OECD Statistics Working Papers 2015/07

Towards a Distribution-Sensitive Better Life Index: Design, Data and Implementation

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https://dx.doi.org/10.1787/5jrqppx9xh8q-en

Organisation de Coopération et de Développement Économiques
Organisation for Economic Co-operation and Development

18-Nov-2015

English - Or. English

STATISTICS DIRECTORATE

STD/DOC(2015)7
Unclassified

Cancels & replaces the same document of 22 October 2015

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STATISTICS DIRECTORATE

WORKING PAPER No 65

This working paper was prepared by Koen Decancq (University of Antwerp, Belgium) as a consultant for the OECD Statistics Directorate.

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JT03386490

English - Or. English

TOWARDS A DISTRIBUTION-SENSITIVE BETTER LIFE INDEX: DESIGN, DATA AND IMPLEMENTATION

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Keywords: Better Life Index, Multi-dimensional well-being, Multi-dimensional inequality.

JEL Classification: I31, C43, O1.

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FOREWORD

The author would like to thank Carlotta Balestra, Romina Boarini, Annemie Nys, Marco Mira d'Ercole, Elena Tosetto as well as participants at presentations in Paris (OECD), Marseille, Uppsala and Luxembourg (ECINEQ) for helpful comments to this or earlier drafts.

ABSTRACT

The *Better Life Index* was introduced by the OECD as a tool to chart the multi-dimensional well-being of OECD member countries, Brazil and the Russian Federation. However, the *Better Life Index* relies only on aggregate country-level indicators, and hence is insensitive to how multi-dimensional well-being outcomes are distributed within countries. This paper discusses how a distribution-sensitive *Better Life Index* could be designed and implemented. Based on five concrete recommendations for the design of the index, a family of indices is suggested. These indices are shown to be decomposable in interpretable building blocks. While a rich and comprehensive micro-level data set is necessary to implement the distribution-sensitive *Better Life Index*, no such data set is currently available for all OECD member countries. The paper proposes a 'synthetic' data set that relies on information about macro-level indicators and micro-level data from the *Gallup World Poll*. The implementation of the distribution-sensitive *Better Life Index* is illustrated with this synthetic data set. While the small sample size and other survey features of the *Gallup World Poll* imply a number of potential biases, illustrative calculations based on this synthetic data set indicates that, when taking distribution into account, Nordic countries are top-ranked whereas Greece, the Russian Federation and Turkey occupy the bottom positions. The results indicate sizeable losses due to multi-dimensional inequality for OECD member countries. Moreover, there are large differences in the level and composition of multi-dimensional inequality.

RÉSUMÉ

L'*Indicateur du vivre mieux* a été lancé par l'OCDE dans le but de cartographier les multiples dimensions du bien-être dans les pays membres de l'OCDE, le Brasil et la Fédération de Russie. Il ne repose toutefois que sur des mesures agrégées à l'échelle nationale et ne permet donc pas de représenter comment se répartissent les différentes dimensions du bien-être à l'intérieur des pays. Ce document étudie la façon dont un *Indicateur du vivre mieux* tenant compte de cette répartition pourrait être élaboré et appliqué. À partir de cinq recommandations concrètes sur la conception de l'indicateur, un ensemble d'indices est proposé. Ces indices peuvent être décomposés en éléments interprétables. Un ensemble de microdonnées dense et exhaustif est nécessaire pour construire un indicateur tenant compte de la répartition des dimensions du bien-être, mais ces données ne sont pas encore disponibles pour l'ensemble des pays membres de l'OCDE. Ce document propose donc un ensemble de données « synthétique » qui s'appuie sur des informations relatives aux macro-indicateurs et aux micro-données de l'enquête *Gallup World Poll*. Même si l'étroitesse des échantillons et autres faiblesses méthodologiques de l'enquête *Gallup World Poll* peuvent entrainer des risques de biais, des mesures basées sur ces données « synthétiques » indiquent que, lorsqu'on tient compte de la répartition des dimensions du bien-être, les pays nordiques arrivent en tête, tandis que la Grèce, la Fédération de Russie et la Turquie occupent les derniers rangs. Les résultats montrent des pertes importantes dues aux inégalités dans la distribution des différentes dimensions du bien-être entre les pays membres de l'OCDE. En outre, on observe de grandes différences de niveau et de composition au regard des disparités multidimensionnelles.

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1. Introduction

1. A wide consensus has emerged in recent years that GDP per capita, or average income, is not a good measure of overall well-being of a country (Stiglitz et al., 2010). Various measures of well-being have therefore been proposed as alternatives to move 'beyond GDP'. In particular, it has been argued that GDP per capita suffers from two structural problems.

2. First, GDP per capita is not sensitive to the shape of the distribution and its inequality. Indeed, two income distributions with the same average income can be very different in terms of inequality, poverty and the share held by the richest. The position that all distributional information is irrelevant to evaluate the well-being of a country is a strong one, and arguably not a very appealing one. To include information on the income distribution in the social evaluation, a so-called social welfare measure can be used (for examples, see Atkinson 1970 and many papers in its wake). A social welfare measure penalizes average income for the inequality in its distribution.

3. Second, GDP per capita includes only information about the incomes of people. It is insensitive to all other dimensions of life that people may care about. This critique has inspired various international institutions to propose their alternative – multi-dimensional – well-being measures. Two measures are particularly popular.[1] Since 1990, the United Nations Development Programme has published annually its *Human Development Index* (HDI) that contains information on three dimensions: material living standards, life expectancy and educational achievements. More recently, the Organization for Economic Cooperation and Development (OECD) has launched its *Better Life Index* (BLI), which includes 11 dimensions of life and covers OECD member countries, Brazil and the Russian Federation (Boarini and Mira D'Ercole 2013, and Durand 2015 for more details). The two measures differ in scope, with the BLI including a broader set of dimensions for fewer countries than the HDI. Moreover, they take a different perspective with respect to the weighting of the dimensions. The HDI gives equal weights to its three components, whereas the BLI allows a flexible selection of the weighting scheme by means of an interactive web application, the *Your Better Life Index* (see www.oecdbetterlifeindex.org).[2]

4. Very few measures address both problems together, i.e. are truly multi-dimensional and distribution-sensitive. An exception is the inequality-adjusted HDI that has been proposed by Alkire and Foster (2010).[3] Until now, no distribution-sensitive BLI has been developed by the OECD. This paper discusses whether and how that lacuna may be filled. To do so, the paper proceeds in three steps.

5. In the first step, the design of a distribution-sensitive *Better Life Index* is discussed by assuming the availability of a 'perfect' data set. This assumption permits to think freely about multi-dimensional indices and their properties, unhindered by feasibility constraints imposed by data availability.[4] Section 2

1 See Yang (2014) for a survey of 101 multi-dimensional measures of well-being or social progress.

2 Users of the BLI web application take the perspective of an (impartial) observer and can see how their value judgements about the weights attributed to various well-being dimensions affect the ranking of countries. This approach is more flexible than using a pre-defined weighting scheme. Still, each comparison remains based on the weighting scheme of one single observer. This approach can therefore be argued to be paternalistic (see Decancq et al. 2015). A non-paternalistic approach would use the weighting scheme of each individual to evaluate their own situation. Decancq and Schokkaert (forthcoming) perform a non-paternalistic comparison of various European countries between 2008 and 2010.

3 Since 2010, this measure has been yearly published by the UNDP as a complement to the standard HDI. An alternative proposal is made by Hicks (1997).

4 Recent theoretical advances in the literature on multi-dimensional inequality and social welfare measurement will be very useful for our analysis (see Weymark, 2006 and Aaberge and Brandolini, 2015 for surveys).

makes five concrete recommendations and discusses a family of distribution-sensitive Better Life Indices that are consistent with them. To be sufficiently flexible and to capture different normative positions, the proposed index contains three normative parameters: i) a weighting scheme for the dimensions; ii) a parameter expressing the degree of complementarity between the dimensions; and iii) the degree of inequality aversion of the social aggregation.

6. Second, a large and broad micro-level data set is needed to implement a distribution-sensitive *Better Life Index* for all OECD member countries, Brazil and the Russian Federation. Ideally, the information in this data set should be comparable across countries and consistent with the established and validated macro-level data that are used to compute the original *Better Life Index*. No micro-level data set is currently available that satisfies these requirements. Section 3 discusses how a 'synthetic data set' could be constructed to approximate it. This synthetic data set relies on the broadest micro-level data set that is currently available, the *Gallup World Poll*, and is constructed to be consistent with the available macro-level data.

7. Using the constructed synthetic data set for 2014 and the index discussed in the first step, Section 4 then implements a distribution-sensitive *Better Life Index*. This index shows that Nordic countries are top-ranked, whereas Mexico, Chile, Greece, the Russian Federation and Turkey are at the bottom of the ranking according to the distribution-sensitive *Better Life Index*. For the benchmark normative parameters, losses due to multi-dimensional inequality are considerable (between 36% and 71%). Finally, a sensitivity analysis discusses the role of the normative parameters when comparing Austria and the United States.

2. Designing a distribution-sensitive *Better Life Index*

2.1. The family of Better Life Indices

8. In 2011, the OECD proposed the *Better Life Index* to measure aggregate well-being of its member countries. To be precise, the OECD proposed an entire family of *Better Life Indices* rather than a single index. As in many families, members may share important features but disagree on some normative matters. Each member of the family of *Better Life Indices* shares the same mathematical structure, but reflects a different position on the philosophical question about the nature of 'the good life'. In particular, the indices disagree on the relative weights that should be given to the different dimensions of life. From the family of indices, the observer – who can be a policy maker, a member of civil society or any citizen – chooses the one that fits best his or her value judgments on the weighting scheme with an interactive web application (see Appendix 1). This flexible and interactive approach is one of the main innovations of the *Better Life Index* and has a clear advantage: it remains neutral with respect to the value-laden question of selecting the weights of the various dimensions. Contrary to other multi-dimensional well-being measures such as the *Human Development Index* (HDI), no weighting scheme is imposed upon its users.[5]

9. This paper calls the family of Better Life Indices that has been originally proposed by the OECD the 'first generation' *Better Life Indices* (*BLI*1s). These indices take two different pieces of information into account, to measure the overall well-being of a country.

10. First, descriptive information is needed on the macro-level outcomes of the country in the various dimensions of life. The OECD selected 11 dimensions of life (Boarini et al. 2012 provide a discussion of

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5 Ravallion (1997), Decancq et al. (2009) and Ravallion (2012) provide a critical discussion of the trade-offs implicit in the HDI.

the selection of the dimensions). These dimensions encompass material living conditions (housing, income, and jobs) and quality of life (community, education, environment, governance, health, life satisfaction, safety, and work-life balance). Most dimensions are measured by one or more indicators, so that in total 24 indicators are considered by *BLI1*. All these indicators are normalized so that they take values between 0 and 1. When a dimension is measured by more than one indicator, the indicators are first averaged within each dimension with equal weights (Boarini et al. 2012).

11. Some notation will be useful in the following. Let l denote the number of dimensions considered. We will refer to the vector of the l normalized macro-level indicators by $m = (m^1, m^2, \dots, m^l)$. The vector of macro-level indicators is used to construct the macro-level data set X_m (Table 1). To each of the n individuals of a country, the respective vector of macro-level indicators is assigned. A row of the data set, denoted x_i, refers to the outcomes of one individual in all the dimensions of life. By construction, all rows of X_m are equal. A column, x^j, refers to the outcomes of all individuals in one dimension.

Table 1. A macro-level data set X_m

	Dim. *1*	…	Dim. *l*
Individual *1*	m^1	…	m^l
Individual *2*	m^1	…	m^l
…	…	…	…
Individual *n*	m^1	…	m^l

12. The observer provides the second piece of information (the weights applied to each dimension) by means of an interactive web application. That information reflects her value judgements on the importance of the l dimensions of life. These importance scores are then normalized so that they sum to 1 and define the weighting scheme $\omega = (\omega^1, \omega^2, \dots, \omega^l)$.[6]

13. Once these two pieces of information are provided, the $BLI1$ aggregates them into a single number. Higher values of the index reflect situations with a higher well-being.[7] The $BLI1$ takes the mathematical structure of a 'mean of means'. More precisely, it can be computed as the mean across all individuals of the weighted mean across all the macro-level indicators:

$$BLI1(X_m|\omega) = \frac{1}{n}\sum_{i=1}^{n}\sum_{j=1}^{l}\omega^j \times m^j. \qquad (1)$$

14. Expression (1) will be a natural starting point when developing a distribution-sensitive measure. By construction, there is no inequality in the macro-level data set X_m (recall that all individuals are assigned the same vector of macro-level indicators). The formula of expression (1) can therefore be simplified to a more familiar result, which does not involve any averaging across individuals.

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6 Mizobushi (2014) proposes a weighting scheme for the *BLI* based on Data Envelopment Analysis. Markovic et al. (2015) discuss the weighting scheme of the *Better Life Index* using a so-called i-distance approach.

7 Kasparian and Rolland (2012) provide a sensitivity analysis of the ranking of the countries based on the choice of weights. They observe a limited role for the weighting scheme on the overall ranking of the countries.

$$BLI1(X_m|\omega) = \sum_{j=1}^{l} \omega^j \times m^j. \quad (2)$$

15. Making this family of well-being indices distribution-sensitive involves a series of small, but structural changes in its design. The resulting new indices will be referred to as the distribution-sensitive Better Life Indices, or second generation Better Life Indices ($BLI2$) for short. Both the descriptive and normative information needs to be adjusted to make the measure distribution-sensitive.

16. A first *conditio sine qua non* for the $BLI2$ to capture the distribution of the outcomes is that the data set contains information on the distribution of well-being between individuals. A macro-level data set as X_m does not contain this information. A micro-level data set is therefore necessary. This leads to our first recommendation.

- **Recommendation 1.** The $BLI2$ should be based on micro-level data, capturing the outcomes of the individuals in all the dimensions of life.

17. Table 2 presents a micro-level data set, denoted X. Again, rows refer to individuals and columns to dimensions. A cell of the data set, x_i^j, contains the outcome of individual i in dimension j. These outcomes are assumed to be measurable on a ratio-scale in such a way that levels are comparable across dimensions.[8]

Table 2. A micro-level data set X

	Dim. *1*	…	Dim. *l*
Individual *1*	x_1^1	…	x_1^l
Individual *2*	x_2^1	…	x_2^l
…	…	…	…
Individual *n*	x_n^1	…	x_n^l

18. Based on the micro-level data set X, the vector $\mu = (\mu^1, \ldots, \mu^l)$ can be derived. This vector contains, for each dimension, the mean obtained from the micro-level data. In analogy to the macro-level data set X_m, a new data set can be constructed that assigns to each individual the vector μ. This smoothed data set will be denoted X_μ. It can be obtained from X by performing in each dimension a sequence of progressive transfers until all individuals obtain the same outcome (equal to the mean value). The resulting distribution is perfectly smoothed and completely equal.

19. In general, the macro-level data set X_m and the smoothed data set X_μ need not to coincide. The (statistical) difference may come from measurement or sampling error in the micro-level data, or because the definition of the micro and macro-level indicators is different. For example, the income per capita measures in national accounts may not coincide with the average income from micro-level household income surveys even when including the same set of income components. It is important to distinguish

8 The assumption that all dimensions are measured on a ratio-scale such that levels are comparable across dimensions is a strong one. See Alkire and Foster, 2010 and Ebert and Welsch 2004 for further discussions.

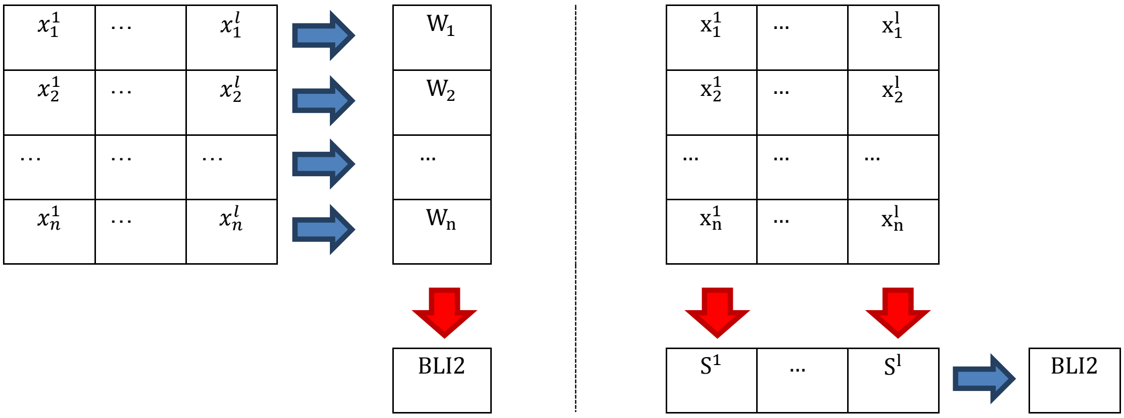
between the statistical difference that comes from the inconsistencies between micro and macro-level data from the normative difference that stems from the inclusion of the distributional information.

20. Second, the normative information that is provided by the observer also needs to be enriched with additional normative parameters. These parameters will capture the value judgments of the observer concerning the distribution of the outcomes, in particular on the desired degree of complementarity between the dimensions of life and on the aversion towards multi-dimensional inequality. Section 2.3 discusses these parameters in detail. First, however, we discuss the general structure of the index.

2.2. The distribution-sensitive Better Life Index as double aggregation

21. A distribution-sensitive *Better Life Index* aggregates across the dimensions and the individuals of the micro-level data set, taking the value judgments of the observer into account. In general, such a double aggregation can be done according to two procedures (see Table 3 for an illustration).[9]

Table 3. Two sequences of aggregation: dimensions first (left) or individuals first (right)



22. In the first procedure (depicted on the left-hand part of Table 3) one aggregates first across the dimensions of life to reach a well-being index W_i for each individual i. Then, in a second step, the resulting well-being indices are aggregated across the individuals. This procedure is most standard in welfare economics, and it reflects an individualistic perspective to well-being (Kolm 1977).

23. Alternatively, the sequence can be reversed (see the right-hand panel of Table 3). This leads to a second procedure. One aggregates first across the individuals in each dimension to obtain a summary statistic S^j for each dimension j. Then, in the second step, the summary statistics are aggregated across the dimensions. This procedure is used by many composite indices (for instance the HDI).[10]

24. In general, the two procedures will lead to different results. In fact, only in specific cases will results according to both sequences coincide. The first generation $BLI1$ is an example of such a specific case. We will return to these specific cases below.

9 For a more formal discussion of the double aggregation problem, see Kolm (1977), Dutta et al. (2002), Pattanaik et al. (2012), Decancq and Lugo (2012), and Decancq (2014) amongst others.

10 Gajdos and Weymark (2005) provide an axiomatic characterization of this sequence of aggregation. Kolm (1977) identified the second method as a specific procedure.

25. Which procedure is preferable? Table 4 provides an illustration with two countries that will help to make up our mind about the desirability of both procedures. For this example, we assume that there are two dimensions of life ($l = 2$). Both countries have three citizens ($n = 3$). When looking at country A (on the left), it can be seen that individual 1 is worst off in dimension 1 and that individual 3 is worst off in dimension 2. Individual 2 scores relatively well on both dimensions. Now, compare this country to country B (on the right). In country B, individual 1 is bottom ranked on both dimensions, while individual 2 is second ranked on both and individual 3 is top-ranked.

Table 4. Comparing two countries with different correlation between the dimensions of life

	Country A		**Country B**	
	Dim. *1*	Dim. *2*	Dim. *1*	Dim. 2
Individual *1*	0.1	0.5	0.1	0.1
Individual *2*	0.4	0.4	0.4	0.4
Individual *3*	0.5	0.1	0.5	0.5

26. In this example, the distributions for the two dimensions are exactly the same in both countries (they are equal to (0,1; 0,4; 0,5) in all cases). Yet, the correlation between the dimensions of life is very different. In country A, individuals doing well in one dimension perform poorly in the other, and the correlation between the dimensions of life is low (even negative), whereas in country B the same individuals are at the top and bottom in each dimension, i.e. the correlation among outcomes at the individual level is much higher. In the welfare literature, we can say that country B is obtained from country A by means of a 'correlation increasing switch'.[11]

27. Most people will agree that the correlation between dimensions of life across individuals matters for welfare comparison of countries.[12] To allow this difference to play a role, the double aggregation described above cannot follow the second procedure (i.e. first aggregating across individuals and then across dimensions, as done on the right -side of Table 3). Indeed, in the first step of the procedure, all information about the correlation is lost, which makes the second procedure insensitive to correlation. The first procedure, which does not suffer from this problem, is therefore preferred. This brings us to the following recommendation.

- **Recommendation 2.** The $BLI2$ performs a double aggregation, across dimensions and individuals. The $BLI2$ should first aggregate across dimensions and then across individuals.

11 A 'correlation increasing switch' considers two individuals and reshuffles their multi-dimensional outcomes so that one individual becomes top-ranked in all dimensions and the other bottom-ranked (see Tsui, 1999 for a formal definition). In Table 4, country B is obtained by a correlation increasing switch from country A between individual 1 and 3.

12 The sensitivity to correlation plays an important role in the literature on multi-dimensional inequality (see Atkinson and Bourguignon, 1982; Dardanoni, 1996; Tsui, 1999; Ferreira and Lugo, 2013; and Decancq, 2014 amongst others). Tarroux (2015) finds that students are averse to correlation in a questionnaire study about multi-dimensional inequality.

28. The concern for the correlation between the dimensions of life strengthens the data requirements further. A perfect data set should not only contain micro-level information on the distribution of each dimension separately; in addition it should also contain information on the correlation between the dimensions of life across individuals. [13] In other words, all information should come from a single micro-level data set that covers all dimensions for all individuals in the same country; and such data set should cover, in a comparable way, all OECD countries. In practice, finding such a broad data set is a huge hurdle, as described in Section 3.

2.3. Incorporating value judgments

29. The previous section argued that the preferred sequence for aggregating is first across dimensions of life and then across people. This section discusses how to perform these two aggregations and how a set of three normative parameters allows incorporating a broad spectrum of value judgments.

30. The function that performs the aggregation across dimensions can be called the 'well-being function' (WB), and is represented by the horizontal arrow in the left-hand panel of Table 3. In principle, the weighted mean formula of the $BLI1$ as given by expression (2) could be used as well-being function. Yet, it is useful to generalize the arithmetic mean further.[14] The generalized mean is a natural generalization of the arithmetic mean, and provides a well-being function that is flexible with respect to the value judgement of the observer concerning the complementarity between the various dimensions of life. It is defined as follows:

$$W_i = WB(x_i|\omega, \beta) = \left(\sum_{j=1}^{l} \omega^j \times \left(x_i^j\right)^{1-\beta}\right)^{\frac{1}{1-\beta}}. \qquad (3)$$

Where the parameter β captures the value judgement of the observer concerning the degree of complementarity between the dimensions of life. The generalized mean has a long pedigree in measurement theory and economics (where it is known as a CES utility function) and has been often proposed to measure well-being of an individual.[15] Various interesting special cases can be reached by adjusting the normative parameter β.

31. The (familiar) case of the arithmetic mean used in the $BLI1$s (see expression (2) for instance) is obtained when β is set equal to 0:

$$WB(x_i|\omega, 0) = \sum_{j=1}^{l} \omega^j \times x_i^j = \omega^1 x_i^1 + \omega^2 x_i^2 + \cdots + \omega^l x_i^l. \qquad (4)$$

This arithmetic mean assumes perfect substitutability between the dimensions. In this case, an individual can be assumed to perfectly compensate a low outcome in one dimension by a higher outcome in another dimension. A decrease of outcomes in dimension 1 of 0.01 units, for instance, can be compensated by an increase in dimension j of $0.01 \times (\omega^1/\omega^j)$ units. This assumption may lead countries

13 On the contrary, most existing multidimensional measures (such as the inequality-adjusted HDI) are obtained based on different data sets for the different dimension. Inevitably these measures are not sensitive to the correlation between the dimensions. Section 2.4 further discusses this point.

14 Although useful to provide normative flexibility to the observer, this generalization is not strictly necessary to make the measure distribution-sensitive.

15 Blackorby and Donaldson (1982) provide an axiomatic characterization of this mathematical structure highlighting the role of the ratio-scale measurability assumption. Maasoumi (1986, 1999) proposes the generalized mean based on considerations from information theory. Anand and Sen (1997) use it as building block in their multi-dimensional poverty measure and Decancq and Lugo (2012, 2013) discuss its use as multi-dimensional well-being index.

to specialize in 'easy' dimensions and result in unbalanced well-being. Some observers have criticized this feature and suggested that a lower degree of substitutability is more appropriate.[16]

32. Another interesting (limit) case is obtained when the observer sets β equal to 1. The well-being function is then a geometric mean and the aggregation becomes multiplicative rather than additive.

$$WB(x_i|\omega, 1) = \prod_{j=1}^{l} \left(x_i^j\right)^{\omega^j} = \left(x_i^1\right)^{\omega^1} \times \left(x_i^2\right)^{\omega^2} \times \ldots \times \left(x_i^l\right)^{\omega^l}. \quad (5)$$

This specification is known by economists as the Cobb-Douglas utility function.[17] In this multiplicative expression, the trade-offs depend not only on the relative weights but also on the levels of the outcomes. A decrease of the outcome in dimension 1 by 1 per cent can be compensated by an increase in dimension j of (ω^1/ω^j) per cent.[18]

33. Increasing the degree of complementarity, captured by the normative parameter β, makes it increasingly difficult to compensate a decrease in one dimension by an increase in another. In the end, when β approaches ∞ we obtain that

$$WB(x_i|\omega, \infty) = min\{x_i^1, x_i^2, \ldots, x_i^l\}. \quad (6)$$

In this situation, the well-being of an individual is determined by the worst outcome across all dimensions of life. In other terms, increasing the outcomes in any other dimension does not affect well-being. A policy maker who wants to improve the well-being of an individual has to focus on her worst outcome. This leads automatically to a more balanced development.[19]

34. Both the relative weights and the normative parameter β affect the trade-offs between dimensions, but their role is different. Figure 1 shows the iso-well-being curves corresponding to various parameter combinations in a two-dimensional case. The outcome in the first dimension is measured on the horizontal axis and those in the second dimension on the vertical axis. An iso-well-being curve connects all outcome vectors that lead to the same well-being level for a particular choice of the parameters ω and β. Comparing the different iso-well-being curves within the same panel of Figure 1 illustrates the role of the parameter β, which expresses the degree of complementarity among well-being dimensions: the higher the value of β, the more curved the iso-well-being curve becomes. Comparing the curve with the same β (shown with the same colour), in both panels illustrates the role of weights. In the right-hand panel, more weight is given to the second dimension, measured on the vertical axis; in the left hand panel, the same weight is attributed to each dimension. Introducing both parameters together leads to a flexible well-being function.[20] This brings us to the third recommendation.

- **Recommendation 3.** The $BLI2$ should incorporate the value judgments of the observer on the weighting scheme and the complementarity across the dimensions.

16 The HDI, for instance, assumes non-perfect substitutability after its revision in 2010.

17 This specification has been used by UNDP to compute the HDI after its revision in 2010.

18 Ebert and Welsch (2004) argue in favour of the multiplicative aggregation because it makes the results ordinally invariant to the choice of the factor used to rescale the dimensions, see also Decancq and Lugo (2012).

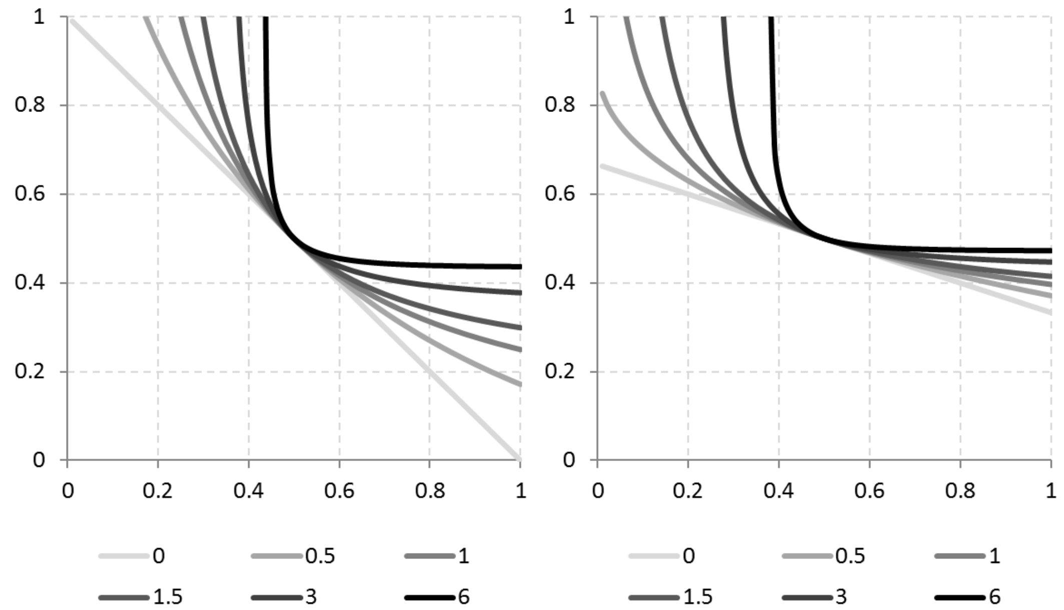
19 Lorzano Segura and Gutierrez Moya (2010) advocate this limit case for a well-being measure.

20 Yet, at this point the reader may be wondering whether observers of the online web application actually know their own β. Appendix 1 discusses how normative parameters can be elicited.

Figure 1. Iso-well-being curves for different values of the parameter on complementary among different dimensions

Panel A. Different weights attributed to each dimension ω=(0.5; 0.5)

Panel B. Same weight attributed to each dimension ω=(0.25;0.75)



35. By choosing particular values for the parameters ω and β, the trade-offs between the dimensions are fixed. These trade-offs can be summarized by means of the marginal rate of substitution (MRS). The MRS between dimensions j_1 and j_2 for individual i captures how much units of dimension j_1 are necessary to compensate individual i for a small decrease in dimension j_2. We have that

$$MRS_{j_1,j_2} = \frac{\omega^{j_1}}{\omega^{j_2}} \times \left(\frac{x_i^{j_2}}{x_i^{j_1}}\right)^{\beta}.$$

Only when aggregation is linear ($\beta = 0$), the MRS depends only on the weights. In general, the choice of the parameter β determines the implied trade-offs (Decancq and Lugo, 2013).[21]

36. Once a well-being index for each individual is obtained, the next step is to aggregate them to obtain an overall well-being score for the country as a whole. A social welfare function, SW, performs this second aggregation (the vertical arrow on the left-hand panel of Table 3). Social welfare functions have been extensively studied in the literature. We work with a standard social welfare function, proposed by Atkinson (1970)

$$SW(W_i|\varepsilon) = \left(\frac{1}{n}\sum_{i=1}^{n} W_i^{1-\varepsilon}\right)^{\frac{1}{1-\varepsilon}}. \qquad (7)$$

21 The MRS between income and a non-income dimension is the so-called 'willingness-to-pay' for the non-income dimension. Computing this value (and comparing it with values obtained by other methods) offers an intuitive check of whether the parameters have been set in a reasonable way (see Clark and Oswald (2002) on how life-evaluation studies can be used to compute willingness-to-pay for non-income dimensions).

37. This function is again based on a generalized mean (as can be seen by comparing expression 3 and 7). The normative parameter ε now captures the observer's aversion to inequality. By setting this parameter equal to 0, the social welfare function becomes an (unweighted) average of the individual well-being indices. This reflects the position of an inequality-neutral observer who does not care about the shape of the distribution. This inequality neutral position is implicit in the first generation of BLI's (see Atkinson, 1970 for a detailed discussion of the interpretation of the normative parameter ε).

38. Increasing the parameter ε increases the weight given to what happens at the bottom of the distribution. In the limit, when ε becomes very large, a Rawlsian social welfare function is obtained that equals the outcome of the worse-off individual in society. The inequality aversion is an essential parameter of the distribution-sensitive better life index. Its inclusion is the next recommendation.

- **Recommendation 4.** The $BLI2$ should incorporate the value judgments of the observer concerning the inequality aversion with respect to well-being.

2.4. The distribution-sensitive Better Life Index defined

39. Once the functional specifications of both aggregations are chosen, the distribution-sensitive Better Life Index can be assembled by substituting expression (3) in expression (7). This leads to the following expression

$$\mathrm{BLI2}(\mathrm{X}|\omega,\beta,\varepsilon)=\left[\frac{1}{n}\sum_{i=1}^{n}\left(\sum_{j=1}^{l}\omega^{j}\times\left(x_{i}^{j}\right)^{1-\beta}\right)^{\frac{1-\varepsilon}{1-\beta}}\right]^{\frac{1}{1-\varepsilon}}. \quad (8)$$

40. This index takes as inputs a micro-level data set X and three normative parameters: the weighting scheme ω, the degree of complementarity β, and the inequality aversion ε.[22] It has been proposed in the literature on multi-dimensional social welfare and inequality measurement by Bourguignon (1999).[23]

41. When comparing expression (8) with expression (1), it is clear that this second generation BLI is a close relative of the first generation BLIs. There are two important differences, however. First, the data set is different: the $BLI2$ makes use of a micro-level data set X, whereas the $BLI1$ is based on macro-level data set X_m. Second, there are two additional normative parameters, β and ε, which allow observers to customize the index in accordance to their value judgments on the distribution of outcomes. Yet, when these additional parameters are both set at the value 0, and the measure is computed based on the macro-level data set X_m, then both measures coincide.[24]

$$\mathrm{BLI2}(\mathrm{X_m}|\omega,0{,}0)=\sum_{j=1}^{l}\omega^{j}\times m^{j}=\mathrm{BLI1}(\mathrm{X_m}|\omega). \quad (9)$$

42. At this point it is useful to reconsider the concern for correlation between the dimensions of life across individuals. We have seen that the aggregation procedure recommended (first across dimensions, and then across individuals) gives a prominent role to this correlation when measuring well-being, contrary

22 Note that the weighting scheme ω is a vector of l dimension-specific weights, whereas the other two normative parameters are scalars. Further generalizations of expression (8) could allow for dimension-specific parameters β as well (see Bourguignon and Chakravarty 2003 for a proposal).

23 Various papers discuss this multi-dimensional social welfare measure (or one of its special cases), e.g. Tsui (1995), Foster et al. (2005), Decancq and Ooghe (2010), Seth (2013), and Bosmans et al. (forthcoming).

24 In fact, as X_m does not contain any inequality by its construction, we also have that $BLI1(X_m|\omega)=BLI2(X_m|\omega,0,\varepsilon)$ for each value of ε.

to the alternative procedure that changes the sequence of aggregation. How and to what extent the resulting index is sensitive to the correlation is determined by the relative values of both normative parameters β and ε. Bourguignon (1999) shows that whenever $\varepsilon > \beta$, an increase in the correlation between the dimensions (by means of a correlation increasing switch) lowers the well-being measure. The higher the complementarity between the dimensions, the higher the inequality aversion has to be for an increase in correlation to lead to a decrease of the $BLI2$ (i.e. a social welfare decline).

43. When ε equals β, the index is invariant to correlation. This choice received some attention in the literature and has been used by the UNDP to define their inequality-adjusted HDI.[25] This special case deserves a closer look. When both parameters are equal, we obtain the following simplified expression

$$\mathrm{BLI2}(\mathrm{X}|\omega, \varepsilon, \varepsilon) = \left[\frac{1}{n}\sum_{i=1}^{n}\sum_{j=1}^{l}\omega^{j} \times \left(x_{i}^{j}\right)^{1-\varepsilon}\right]^{\frac{1}{1-\varepsilon}}. \qquad (10)$$

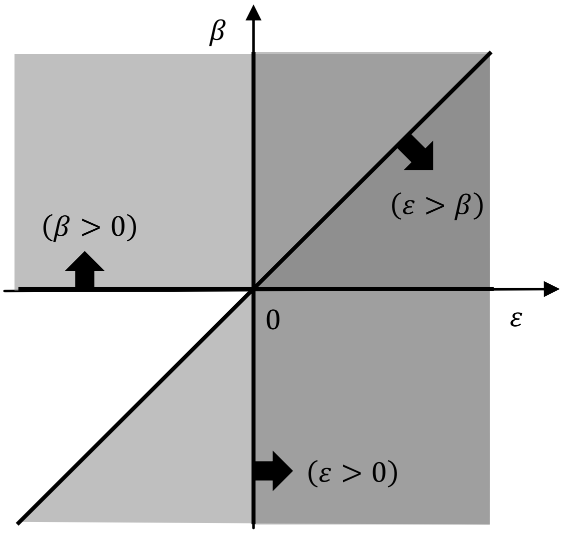
44. Inspecting this expression, it is clear that both summation signs can be exchanged without affecting the result. In other words, when ε equals β, both aggregation procedures lead to the same result. As a consequence, the simplified index is invariant to correlation between life dimensions. This simplification allows the data set to be constructed from different data sources, each providing distributional information for one single dimension. This is the main practical advantage of the simplified measure.

45. Yet, is the simplification normatively appealing? To address this question it is useful to remind readers of the precise interpretation of both parameters. The parameter β captures the degree of complementarity between the dimensions, i.e. whether they can be seen as perfect substitutes ($\beta = 0$) or as complements (for larger values of β). The parameter ε, on the other hand, captures the inequality aversion of individuals (the larger ε, the larger the aversion to inequality). Both parameters capture a very different aspect of the multi-dimensional evaluation. There is no reason why both normative parameters should be equal. Both normative parameters play a separate role and have their own *raison d'être*. Equalizing them *a priori* is a very strong requirement. It seems therefore more appealing to work with the flexible measure (expression 8) rather than the simplified one (expression 10).

46. We can collect all restrictions on the normative parameters β and ε and summarize them graphically. Figure 2 presents a normative space for the parameters β and ε. The parameter β captures the value judgments of the observer about the degree of complementarity between the dimensions of life. Observers with a preference for a balanced well-being across the dimensions will choose a value for β that is larger than 0. The parameter ε captures the inequality aversion. Observers who are averse to inequality will set ε larger than 0. Combining these two requirements brings us to the upper right-hand quadrant of the Figure 2. Observers who want to work with a welfare measure that falls when the correlation of well-being outcomes among individual rises will select values of the parameters below the diagonal shown on Figure 2. All points on the diagonal are invariant to the sequence of aggregation, and hence to correlation between the dimensions of life. For a measure that reflects a positive complementarity between the dimensions, the normative parameter space is restricted to $\varepsilon > \beta > 0$ (i.e. the dark shaded triangle on Figure 2). The normative position taken by the $BLI1$ is reflected by the origin.

25 Foster et al. (2005) propose a closely related index as a distribution-sensitive well-being measure and study its properties.

Figure 2. Restrictions on the complementarity parameter β and the inequality aversion parameter ε



2.5. Decomposing the distribution-sensitive Better Life Index

47. The distribution-sensitive Better Life Index can be decomposed in different components that have specific interpretations. A first decomposition expresses the distribution-sensitive $BLI2$ as a product of the 'potential $BLI2$' and the 'loss due to multi-dimensional inequality'.[26]

$$\underbrace{BLI2(X|\omega,\beta,\varepsilon)}_{\substack{distribution- \\ sensitive \\ BLI2}} = \underbrace{BLI2(X_\mu|\omega,\beta,0)}_{Potential\ BLI2} \times \left[1 - \underbrace{\left(1 - \frac{BLI2(X|\omega,\beta,\varepsilon)}{BLI2(X_\mu|\omega,\beta,0)}\right)}_{\substack{loss\ due\ to \\ multidimensional \\ inequality}}\right]. \qquad (11)$$

48. Even though this decomposition is a simple accounting equation, it is interesting because it brings to the fore the loss due to multi-dimensional inequality. Potential $BLI2$ is the $BLI2$ of the smoothed data set X_μ rather than the actual micro-level data set X. Potential well-being matches total well-being when inequality within each dimension could be eliminated without any cost. Potential $BLI2$ does not depend on the inequality aversion parameter ε but does depend on the normative parameters ω and β.

49. The second term of the decomposition, the loss due to multi-dimensional inequality, ranges between 0 and 1 and can be interpreted as a percentage.[27] The larger the inequality in the micro-level data set X, the larger the measure. In addition, the larger the inequality aversion parameter ε, the larger is the loss due to multi-dimensional inequality.

50. This decomposition highlights in a natural and intuitive way the fundamental trade-off between average outcomes and the inequality of the well-being distribution. The potential $BLI2$ depends on the smoothed data set X_μ and measures average well-being, whereas the loss due to multi-dimensional inequality captures the loss in $BLI2$ due to the shape of the multi-dimensional distribution. The

26 Alkire and Foster (2010) discuss a similar notion of a 'potential HDI'.

27 The loss due to multi-dimensional inequality was initially proposed by Kolm (1977) as a 'normative measure of multi-dimensional inequality'. See Weymark (2006) for a survey of the literature on normative multi-dimensional inequality measures. Bosmans et al. (frthc) give a critical discussion of its interpretation.

distribution-sensitive $BLI2$ combines both aspects. It is recommended that all three components be shown as output.[28]

- **Recommendation 5.** The $BLI2$ should present the observer information on the distribution-sensitive $BLI2$, the potential $BLI2$, and the loss due to multi-dimensional inequality.

3. Data for the distribution-sensitive *Better Life Index*

51. The previous section assumed that a perfect data set was available. Such a perfect data set has to satisfy several stringent conditions. First, it should be a large micro-level data set with information about the selected dimensions of life for a representative sample of citizens of all countries of interest.[29] Second, the micro-level data set should be consistent with the 'official' and validated macro-data sources whenever they are available. Third, it should satisfy standard requirements of statistical quality such as comparability across countries, timeliness, etc. (Boarini et al. 2012).

52. Unfortunately, no single data set currently meets all these requirements. The data set that presumably comes closest to satisfying these conditions is the *Gallup World Poll*. This survey includes most of the countries of interest. While not all 11 dimensions of the *Better Life Index* are covered equally well by the *Gallup World Poll*, for most dimensions a reasonable proxy is available. The main disadvantage of the data set is that it is collected by the private company Gallup and that access is limited, which makes scientific validation and systematic replication of the results by different researchers virtually impossible. Moreover, both the sampling procedure and the small sample size of the survey affect the quality of the survey (Gasparini and Glüzmann, 2012). For these reasons, the *Gallup World Poll* cannot be considered as a perfect micro-level data set.

53. In absence of a perfect micro-level dataset, the first-best solution would arguably be to collect the missing data. Given the size and broadness of the ideal micro-level dataset, this strategy is likely to be very costly.[30] A second-best strategy is to construct a so-called 'synthetic' micro-level data set. This data set would be constructed so as to be consistent with the pieces of well-being information that are available from different existing data sets. Constructing a complete synthetic data set based on scattered pieces of information requires some – arguably strong – assumptions. [31] This section provides an illustration of how this could be done using two pieces of information that we have discussed earlier. First, there is the 'official' and validated vector $m = (m^1, m^2, \dots, m^l)$ containing (mainly) macro-level data that are currently used to compute the $BLI1$. Second, the *Gallup World Poll* can be used, as it provides information (or reasonable approximations) about the distribution of most of the 11 dimensions of well-being and on the correlation between the well-being outcomes at the individual level.

54. Combining information about the average outcome from a macro source with distributional information from a micro source is common practice in the one-dimensional literature on global income

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28 Appendix 2 discusses how both components of equation (11) can be decomposed further.

29 In our setting, these are the OECD member countries and some emerging economies such as Brazil, the Russian Federation, India, China, and South Africa (the so-called BRICS countries).

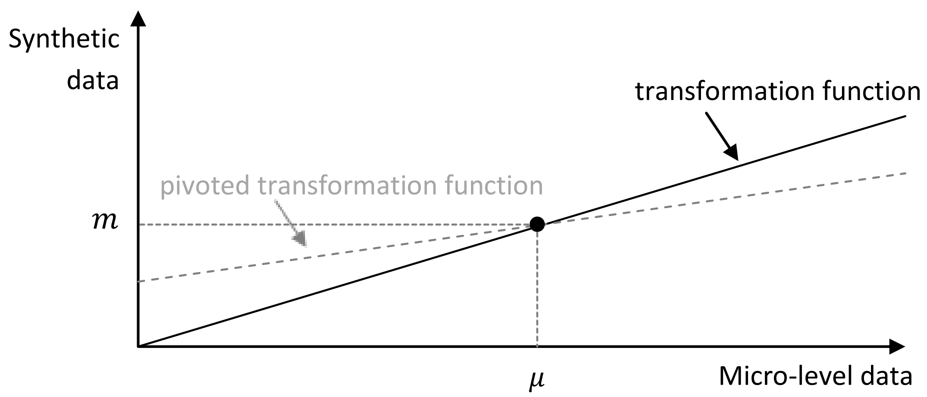
30 In fact, it may not be necessary to create an entirely novel data set *ex novo*. It may suffice to develop a battery of 'ideal' questions or guidelines for constructing such a data set.

31 Amongst others, it is assumed that all outcomes to be measured on a ratio-scale, i.e. they have a natural 0 and it is assumed that ratios of values can be meaningfully compared.

inequality.[32] In these studies, the mean of the income distribution of a country is anchored on information from its national accounts (e.g. on its GDP per capita), while information about the shape of the distribution comes from micro income data obtained from household surveys (or from parametric models estimated based on these surveys). The simplest procedure to construct such a synthetic data set is to rescale or uprate all incomes in the household survey with a factor that equals the ratio between macro variable (e.g. GDP per capita) and the average income from the household survey. This procedure assures that the average of the resulting synthetic distribution correspondents perfectly to the 'official' information from the national accounts. In addition, the inequality of the synthetic distribution (measured by a Gini coefficient, for instance) remains consistent with that from the household surveys.

55. This paper constructs a synthetic data set based on two sources (a validated macro-level data set, i.e. the one used by the OECD for the *Better Life Index*; and a micro-level data set, the *Gallup World Poll*) inspired by the approach used in the literature on global income inequality. In this approach, the variables from the *Gallup World Poll* are rescaled so that their averages match the validated macro information. Figure 3 illustrates the procedure for a single variable. The micro-level data from *Gallup World Poll* (together with their average μ) are plotted on the horizontal axes. A linear transformation function (the black full line on Figure 3) rescales all micro-level data by the factor m/μ. The synthetic data can then be read on the vertical axis. The average of the synthetic data coincides with m, the validated macro-level information about the average. Moreover, as the transformation function does not change the ranking of the individuals in each dimension, the (rank) correlation structure between the different dimensions of life of the synthetic data set coincides with that from the underlying micro-level data set.

Figure 3. Transformation of the micro-level data into a synthetic variable with the same mean as in the macro-series



56. Let us discuss the implementation of this procedure in more detail, starting from the macro-level data set. For 10 out of the 11 dimensions of the $BLI1$, the approach relies on the validated macro-level variables as collected and validated by the OECD for the $BLI1$ (see Table 5, left column; these 10 dimensions are denoted with a *).[33] Since the macro-level data are available for each country by gender, the approach considers separately, for each country, its female and male population. The method illustrated in Figure 3 above is hence applied to each of these groups separately.

32 Anand and Segal (2008) provide a survey and a critical discussion of this procedure.

33 Data were last updated on 3/12/2014.

57. For the purpose of measuring well-being and its inequality, two modifications of the normalization procedure followed by the OECD for the $BLI1$ have been made. First, the linear normalization used by the OECD to map the outcomes in each variable between 0 and 1 is replaced by a simple rescaling of the variables by their maximal value. Loosely speaking, the latter modification provides some space in the relevant interval of a distribution around its average performance also for the worse performing countries. Second, the indicator used by the OECD to measure *Personal Security* (homicide rates) has been changed to a more micro-oriented variable, i.e. self-reported safety.[34]

58. Concerning the micro-level data, four waves of *Gallup World Poll* (2010-2013) have been pooled for each country considered. [35] The analysis retains only individuals for whom information is available for all well-being dimensions, which leads to sample sizes of about 900 respondents in Norway and 9,000 in the Russian Federation. In Table 5 (right column), the indicators from the *Gallup World Poll* which are used to approximate the joint distribution are denoted with (**). Whenever more than one indicator from the *Gallup World Poll* has been used for one dimension, the indicators are first averaged at the individual level (using equal weights).

59. Before proceeding to the results, three comments about the synthetic data should made.

- First, as is clear from Table 5, no good proxy is available in the *Gallup World Poll* for three well-being dimensions ('Housing', 'Work/Life Balance', and 'Civic Engagement'). For these dimensions, their distribution is assumed to perfectly equal across individual.[36] The rescaling procedure illustrated in Figure 3 then results in a synthetic variable where all individuals have the macro indicator of their country, as for the $BLI1$.[37]

- Second, for the dimension 'Income and Wealth', some additional (and validated) distributional information is available. The OECD collects high quality data on income distribution in its Income Distribution Database (IDD). The micro-level data from *Gallup World Poll* are not always well-aligned with the information in the IDD database. Some further adjustment of the *Gallup World Poll* income data is therefore desirable. A similar method can be used to adjust the Gini coefficient of the synthetic data to match that from the validated source (IDD, see Figure 3).

34 Appendix 3 describes these modifications and their effect on the results in more detail.

35 Data were pooled across the four waves to enlarge sample sizes. In most countries, the sample size of the *Gallup World Poll* is rather small (about 1,000 respondents in every wave). Interviews take place by telephone in countries where the telephone coverage is at least 80%, and face-to-face in other countries.

36 An alternative solution would be to enrich the initial micro-level data (i.e. *Gallup World Poll* in our illustration) by 'merging' it with other data sets which have some variables in common. This would require using statistical techniques such as (regression) imputation or statistical matching. In the first approach, a regression model would be estimated on a secondary micro-level data set and used to predict (or impute) the values of the missing dimensions in the initial data set. Alternatively, the information from different data sets could be merged by matching each individual in the initial data set with the closest individual in the secondary data set according to some common variables. Finally, a so-called 'copula function' could be used to model the correlation structure between the dimensions separately from the distributional shape of each dimension (Nelsen, 2006 gives a detailed introduction to the copula). Decancq (2014) uses the copula function to measure and quantify changes in the correlation structure between three dimensions of life in the Russian Federation.

37 This assumption may introduce a bias when estimating multi-dimensional inequality. The direction of the bias is not certain, however, as there the missing dimensions may be negatively correlated with the observed dimensions: in this case, the consideration of their inequality may reduce multi-dimensional inequality when measured with a correlation-sensitive measure (that is when $\varepsilon > \beta > 0$).

Rather than the black full transformation function, the gray dashed transformation function is used.[38] This new transformation function is obtained by pivoting the original one around the point (μ, m), which assures that the average of the synthetic income distribution remains fixed at the macro-level indicator m. The lower slope of the grey dashed line compared to the black line implies a reduction of the inequality of the synthetic income variable. By selecting the appropriate slope for the pivoted transformation function, the Gini coefficient of the synthetic data can be matched to the external distributional information. The extent of pivoting necessary to achieve this result differs across countries.[39]

- Third, for almost all dimensions in Table 5, the definitions of the variables used in columns 2 and 3 are not precisely identical. The method used assumes that the distributional shape of the variable in column 3 provides a reasonable approximation of the shape of the distribution for the variable in column 2. In the case of education, for example, each individual with a high number of years of schooling (the micro-level variable measured by *Gallup World Poll*) is assumed to have a high score on the BLI macro indicator, which is constructed as an average of the variables 'educational attainment', 'education expectancy' and 'students' cognitive skills'. Without additional information it is hard to judge how reasonable this and related assumptions really are.

60. In line with the discussion of Section 2, the synthetic data is called X. The resulting country-specific averages and Gini coefficients of the synthetic data set are provided in Appendix 4. Figure 4 provides the Lorenz-curves for two countries, Austria and the United States for the 8 dimensions for which distributional information is available. The Lorenz curve shows which percentage of the variable considered (e.g. total outcome) a certain bottom percentage holds: the closer the Lorenz-curves are to the black diagonal line, the lower inequality in that dimension. The top left-hand panel shows that Austria has a more equal income distribution than the United States. The distribution of most other dimensions of life is also more equal in Austria than in the United States (only for education the Lorenz-curves cross).

61. Table 6 and 7 show the (rank) correlation matrix for Austria and the United States. In each cell the Spearman rank correlation coefficient is reported. These tables show how the correlation structure between the dimensions of life (captured by micro-level data set) is remarkably different. The correlation between the positions of the non-income dimensions and income is much higher in the United States compared to Austria.[40] Richer individuals in the United States are more likely to occupy the top positions in the other dimensions of life as well.[41]

38 Quite sophisticated alternative statistical approaches are available. Without going in technical details here, it is possible to use the validated quantile function (or a parametric estimate thereof) to compute for each of the observed quantiles in the *Gallup World Poll* the corresponding income level, for instance.

39 It should be noted that the income concept is not entirely identical in the micro and macro data sets: in the macro data, the concept used is that of disposable household income, whereas the *Gallup World Poll* question refers to pre-tax income. The transformation function can therefore be interpreted as an approximation of the actual taxation system by a negative income tax. Yet, measurement and sampling error contaminate this interpretation.

40 The remarkable (negative) correlations with the employment status deserve further research.

41 See Decancq (2014) for a discussion about the measurement of dependence between dimensions of well-being in the Russian Federation.

Table 5. Overview of the variables used to construct a synthetic well-being dataset from different sources

Dimension	Information about mean from validate macros sources	Information about distribution
Income and Wealth	Household net adjusted disposable income and Household net financial wealth (*)	Distribution of (Imputed) income per capita (**) linearly transformed to match validated Gini Coefficient (of income after taxes) (*)
Jobs and Earnings	Employment rate, Personal earnings, Employment insecurity, and Long-term unemployment rate (*)	Distribution of an indicator of Employment (**)
Housing	Number of rooms per person, Housing expenditure, and Dwellings without basic facilities (*)	Equal distribution assumed
Health	Life expectancy at birth and Self-reported health (*)	Distribution of mean of indicator of Satisfaction with health and Absence of health problems (**)
Work/Life Balance	Employees working very long hours and Time non-worked (*)	Equal distribution assumed
Education and Schooling	Educational attainment, Education expectancy, and Students' cognitive skills (*)	Distribution of Years of schooling (**)
Social Connections	Social network support (*)	Distribution of indicator of Social network support (**)
Civic Engagement	Transparency of governance and Voter turn-out (*)	Equal distribution assumed
Environmental Quality	Satisfaction with water quality and air pollution (*)	Distribution of mean of indicator of Satisfaction with water quality and air pollution (**)
Personal Security	Self-reported safety (**)	Distribution of mean of indicator of Self-reported safety (**)
Subjective Well-Being	Life satisfaction (*)	Distribution of Life satisfaction (**)

Note: All BLI macro variables are computed by the OECD as weighted averages of normalised variables shown in column 2.

Legend: (*) Macro-level data from OECD (2014).

(**) Micro-level data from *Gallup World Poll* (2010-2013).

Table 6. Rank correlation matrix for the eight non-equal dimensions based on the synthetic data, Austria

Spearman correlation

Austria	Income and Wealth	Jobs and Earnings	Health	Education and Schooling	Social Connect-ions	Environ-mental Quality	Personal Security	Subjective Well-Being
Income and Wealth	1.000							
Jobs and Earnings	0.061*	1.000						
Health	0.047*	-0.464*	1.000					
Education and Schooling	0.165*	-0.393*	0.341*	1.000				
Social Connections	-0.009	0.648*	-0.452*	-0.401*	1.000			
Environmental Quality	0.0024	-0.484*	0.403*	0.2925*	-0.525*	1.000		
Personal Security	0.021	-0.434*	0.391*	0.314*	-0.432*	0.445*	1.000	
Subjective Well-Being	0.086*	0.084*	0.105*	0.048*	0.161*	0.010	0.036*	1.000

Note: * denotes significant differences from 0 ($p < 0.05$)

Table 7. Rank correlation matrix for the eight non-equal dimensions based on the synthetic data, the United States

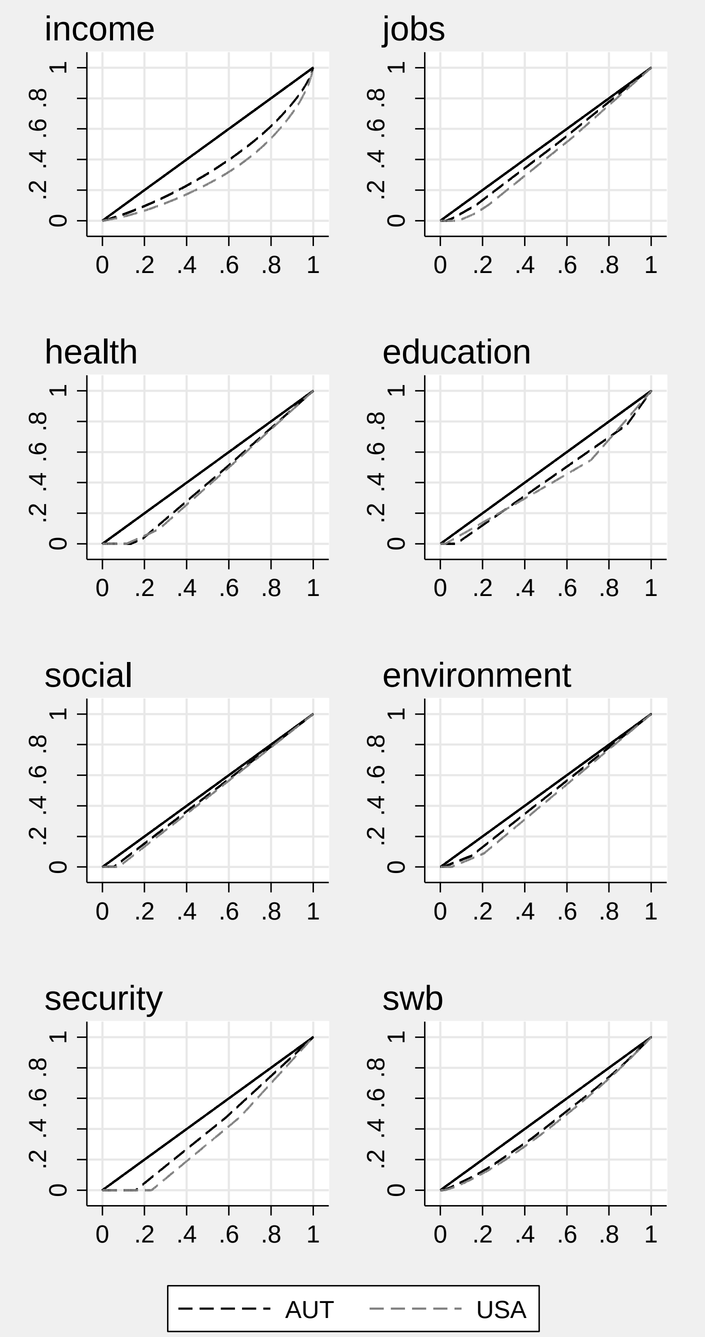
Spearman correlation

United States	Income and Wealth	Jobs and Earnings	Health	Education and Schooling	Social Connect-ions	Environ-mental Quality	Personal Security	Subjective Well-Being
Income and Wealth	1.000							
Jobs and Earnings	0.093*	1.000						
Health	0.085*	-0.315*	1.000					
Education and Schooling	0.240*	-0.218*	0.299*	1.000				
Social Connections	0.030	-0.505*	0.480*	0.418*	1.000			
Environmental Quality	0.060*	-0.336*	0.387*	0.2700*	0.556*	1.000		
Personal Security	0.052*	-0.220*	0.284*	0.270*	0.365*	0.320*	1.000	
Subjective Well-Being	0.187*	0.110*	0.179*	0.078*	0.018	0.057*	0.074*	1.000

Note: * denotes significant differences from 0 ($p < 0.05$)

Source: OECD (2014) and Gallup World Poll (2010-2013)

Figure 4. Lorenz curves for eight dimensions of life, Austria and the United States



Source: OECD (2014) and Gallup World Poll (2010-2013)

4. Implementation of the distribution-sensitive Better Life Index with a synthetic data set

4.1. The distribution-sensitive Better Life Index for 2014

62. As described in Section 2, computing a distribution-sensitive *Better Life Index* requires not only a large data set, but also making choices on the three normative parameters ω, β and ε (see equation 8). As, for practical reasons, it is impossible to show results for all possible normative parameter values, the empirical results described in this section use as weighting scheme (ω) the average weights given by the registered users of the *Better Life Index* web-site.[42] These weights are shown in Figure 5. Even though the default option for the users is an equal weighting scheme, it is clear that users gave higher weights to 'Health' and 'Subjective Well-Being', and lower weight to the dimension 'Civic Engagement'.[43]

Figure 5. Average weighting scheme of users of *the Better Life Index*

Source: OECD (2014) and Gallup World Poll (2010-2013)

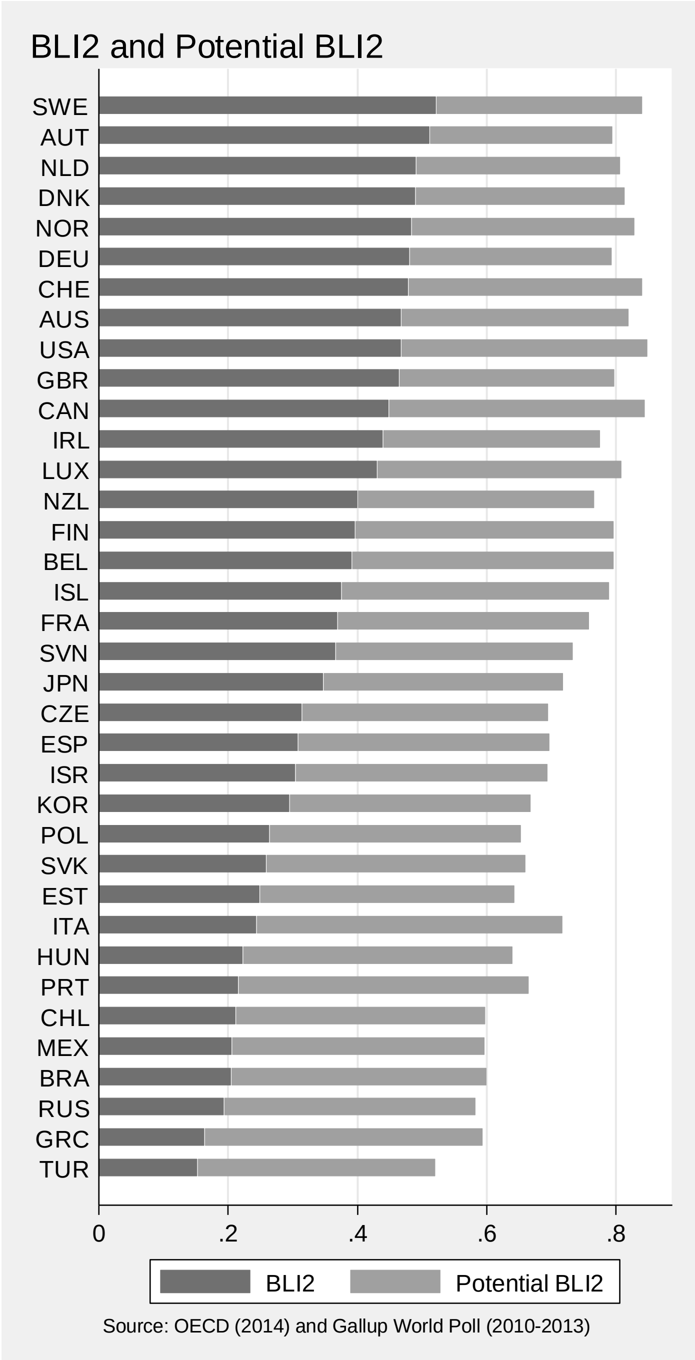
63. We start our discussion of the results for particular values of the two normative parameters. The degree of complementarity β is first set at a value of 1. This makes the aggregation multiplicative and introduces a slight curvature in the iso-well-being curves (Figure 1). The value of the inequality aversion parameter ε is set at 2. This choice implies a considerable inequality-aversion. These parameter values introduce an aversion to correlation in the index, since $\varepsilon > \beta > 0$. Later in this section we will relax these parameter choices and see how the results change when different values for β and ε are selected.

42 The data are collected in June 2013 and include more than 37,700 responses.

43 To what extent the implied marginal rates of substitution are reasonable and in line with other research findings, is an interesting question for further research.

Figure 6. BLI2 and potential BLI2

ε=2 and β=0



64. Figure 6 provides the key result of this section. It shows the $BLI2$ and the potential $BLI2$ for the countries considered, with countries ranked according to their $BLI2$ (the overall well-being of each country when taking distribution into account). Potential $BLI2$ measures total well-being if the inequality in each

dimension could be eliminated without any cost.[44] The well-being loss due to multi-dimensional inequality is given by 1 minus the ratio between both measures multi-dimensional (recall the decomposition in equation 11). This loss is shown in Figure 7. For the selected normative parameters, losses are considerable and range between 36% and 71% for Austria and Turkey, respectively. The level of this loss obviously depends on the choice of the normative parameters.

65. Sweden, Austria, Netherlands, Denmark and Norway are the countries with the highest $BLI2$. Mexico, Brazil, Mexico, the Russian Federation, Greece and Turkey are at the bottom of the ranking. When looking at the top-five performers in Figure 6, the potential $BLI2$ of Norway is higher than the one of Austria, whereas Austria has a higher $BLI2$. The loss due to multi-dimensional inequality is larger in Norway as compared to Austria (see Figure 7). In general, countries at the bottom of the $BLI2$ ranking also have a larger loss due to multi-dimensional inequality. This means that countries with worse well-being performance combine both low average scores for the various dimensions of life and high multi-dimensional inequality. A similar pattern is highlighted by the inequality-adjusted HDI (UNDP, 2014).

66. Column 1 and 2 of Table 8 present values of the $BLI2$ and potential $BLI2$ for all countries. The ranking of each country according to each variable is shown in italics. Although the rank-correlation between $BLI2$ and potential $BLI2$ is high (Spearman's rank correlation coefficient is 0.94), the ranking of some countries is affected strongly when taking the multi-dimensional well-being distribution into account. The United States loses 10 positions, whereas Austria gains 11, for instance. This re-ranking is entirely driven by the loss in $BLI2$ due to multi-dimensional inequality (as shown in column 3 of the table).

44 Recall that, by construction, there is no inequality in the dimensions 'Housing', 'Work/Life Balance' and 'Civic Engagement'.

Figure 7. BLI2 loss due to multi-dimensional inequality

ε=2 and β=1

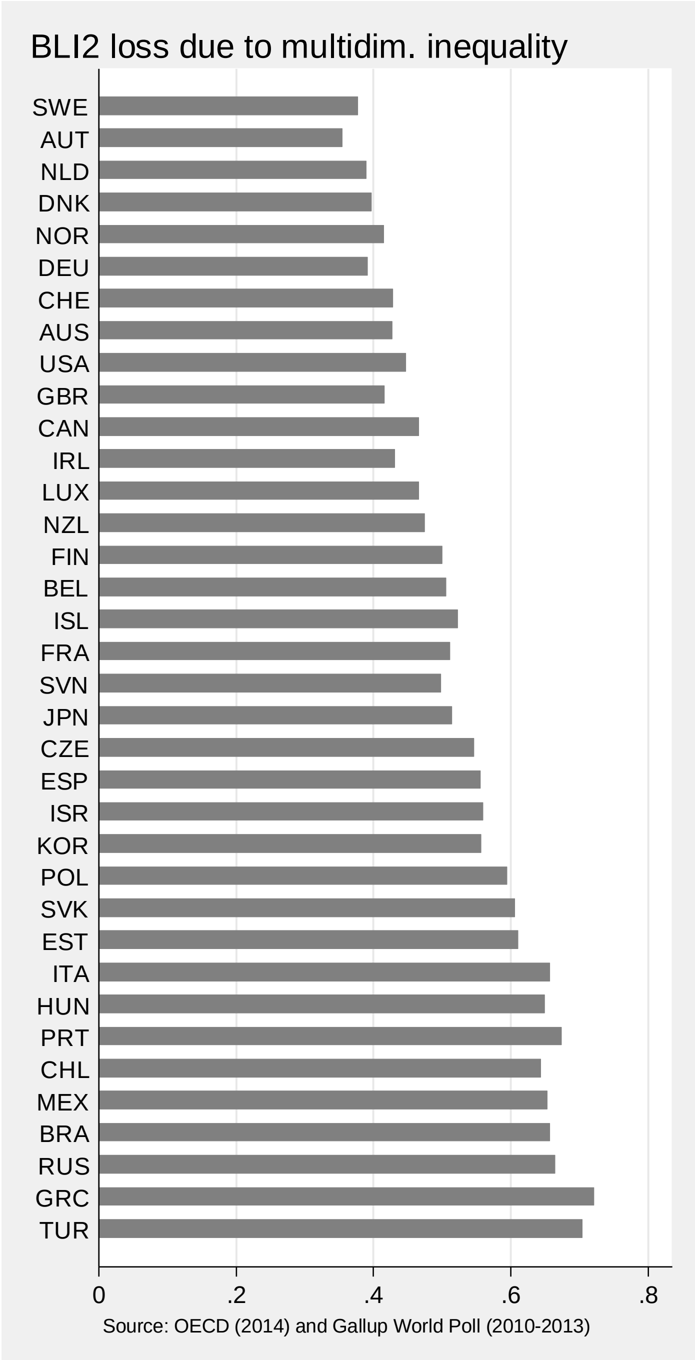


Table 8. BLI2 and potential BLI2 for OECD countries under two normative cases

	Benchmark case (ε=2 and β=1)						**Alternative case (ε=1 and β=0.5)**					
Country	$BLI2$		Potential $BLI2$		*Loss in $BLI2$ due to inequality*		$BLI2$		Potential $BLI2$		*Loss in $BLI2$ due to inequality*	
Australia	0.469	*8*	0.821	*6*	43%	*8*	0.759	*7*	0.826	*6*	8%	*10*
Austria	0.512	*2*	0.796	*13*	36%	*1*	0.753	*9*	0.803	*11*	6%	*1*
Belgium	0.393	*16*	0.797	*12*	51%	*17*	0.721	*15*	0.801	*13*	10%	*16*
Brazil	0.205	*33*	0.601	*31*	66%	*31*	0.525	*31*	0.632	*31*	17%	*32*
Canada	0.450	*11*	0.846	*2*	47%	*13*	0.776	*4*	0.849	*2*	9%	*12*
Chile	0.213	*31*	0.599	*32*	65%	*28*	0.518	*32*	0.620	*32*	17%	*30*
Czech Republic	0.315	*21*	0.696	*23*	55%	*21*	0.632	*22*	0.712	*23*	11%	*21*
Denmark	0.490	*4*	0.815	*7*	40%	*5*	0.765	*6*	0.824	*7*	7%	*4*
Estonia	0.250	*27*	0.645	*29*	61%	*27*	0.574	*28*	0.670	*29*	14%	*27*
Finland	0.398	*15*	0.798	*11*	50%	*16*	0.726	*13*	0.808	*10*	10%	*17*
France	0.370	*18*	0.760	*18*	51%	*18*	0.687	*18*	0.765	*18*	10%	*17*
Germany	0.482	*6*	0.794	*14*	39%	*4*	0.742	*10*	0.800	*14*	7%	*5*
Greece	0.165	*35*	0.595	*34*	72%	*36*	0.496	*35*	0.611	*34*	19%	*35*
Hungary	0.224	*29*	0.641	*30*	65%	*29*	0.555	*30*	0.660	*30*	16%	*29*
Iceland	0.376	*17*	0.791	*15*	52%	*20*	0.706	*17*	0.800	*14*	12%	*22*
Ireland	0.441	*12*	0.777	*16*	43%	*10*	0.724	*14*	0.787	*16*	8%	*7*
Israel	0.305	*23*	0.696	*23*	56%	*24*	0.620	*23*	0.707	*24*	12%	*24*
Italy	0.245	*28*	0.718	*21*	66%	*32*	0.604	*24*	0.724	*20*	17%	*31*
Japan	0.348	*20*	0.719	*20*	52%	*19*	0.644	*20*	0.724	*20*	11%	*19*
Korea	0.296	*24*	0.669	*25*	56%	*23*	0.597	*25*	0.679	*26*	12%	*23*
Luxembourg	0.431	*13*	0.810	*8*	47%	*12*	0.742	*10*	0.813	*9*	9%	*13*
Mexico	0.207	*32*	0.598	*33*	65%	*30*	0.514	*33*	0.619	*33*	17%	*33*
Netherlands	0.492	*3*	0.808	*9*	39%	*3*	0.756	*8*	0.814	*8*	7%	*3*
New Zealand	0.402	*14*	0.768	*17*	48%	*14*	0.711	*16*	0.784	*17*	9%	*14*
Norway	0.484	*5*	0.830	*5*	42%	*6*	0.775	*5*	0.840	*5*	8%	*6*
Poland	0.265	*25*	0.654	*28*	60%	*25*	0.584	*27*	0.676	*27*	14%	*25*
Portugal	0.216	*30*	0.667	*26*	68%	*34*	0.569	*29*	0.676	*27*	16%	*28*
Russian Federation	0.195	*34*	0.585	*35*	67%	*33*	0.504	*34*	0.609	*35*	17%	*34*
Slovak Republic	0.260	*26*	0.661	*27*	61%	*26*	0.586	*26*	0.680	*25*	14%	*26*
Slovenia	0.367	*19*	0.735	*19*	50%	*15*	0.679	*19*	0.749	*19*	9%	*14*
Spain	0.309	*22*	0.698	*22*	56%	*22*	0.633	*21*	0.713	*22*	11%	*20*
Sweden	0.523	*1*	0.842	*3*	38%	*2*	0.790	*1*	0.848	*3*	7%	*2*
Switzerland	0.480	*7*	0.842	*3*	43%	*9*	0.777	*3*	0.846	*4*	8%	*9*
Turkey	0.154	*36*	0.522	*36*	71%	*35*	0.436	*36*	0.545	*36*	20%	*36*
United Kingdom	0.466	*10*	0.799	*10*	42%	*6*	0.740	*12*	0.803	*11*	8%	*7*
United States	0.469	*8*	0.850	*1*	45%	*11*	0.780	*2*	0.852	*1*	9%	*11*

Source: OECD (2014) and Gallup World Poll (2010-2013)

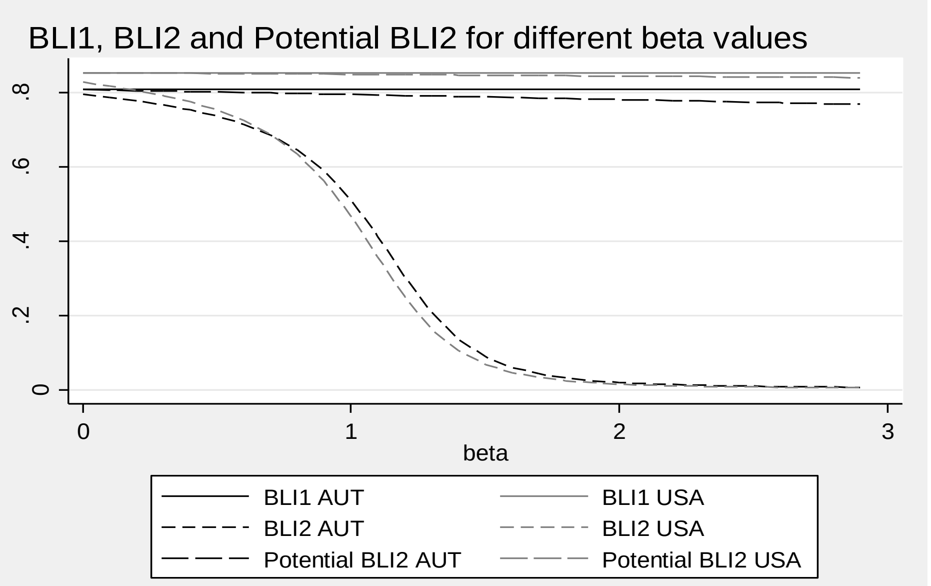
4.2. Sensitivity analysis

67. How do results change for other choices of the normative values? The last three columns of Table 8 show results for an alternative case with (ε=1 and β=0.5). In this case both the degree of complementarity and inequality aversion are lower than in the benchmark case. Also losses due to multi-dimensional inequality are much lower (between 6% and 19%). This finding illustrates that the magnitude of the loss due to multi-dimensional inequality depends on the normative parameters and should be interpreted with care.

68. How sensitive the results are with respect to the normative parameters can be illustrated in the case of Austria and the United States, two countries with very different ranking based on $BLI2$ and potential $BLI2$ (see Figure 6), and different inequality levels within the different dimensions (see Figure 4).

69. We first look at the role of the normative parameter β, which captures the degree of complementarity between the dimensions of life. Figure 8 shows the evolution for $BLI1$, potential $BLI2$ and $BLI2$ for Austria (in black) and the United States (in gray) for different values of β. We keep the value of ε (the degree of aversion to inequality) fixed at 2. As can be seen from its definition (expression 9), the $BLI1$ does not depend on β. Figure 8 shows that the size of potential $BLI2$ depends only marginally on the parameter β. The United States score better than Austria in terms of both the potential $BLI2$ and the $BLI1$ (the long-dashed line and full line respectively). Indeed, Figure 6 also showed that the United States has a higher potential $BLI2$ than Austria for the benchmark normative parameters.

Figure 8. BLI1, potential BLI2 and BLI2 for different values of the parameter β



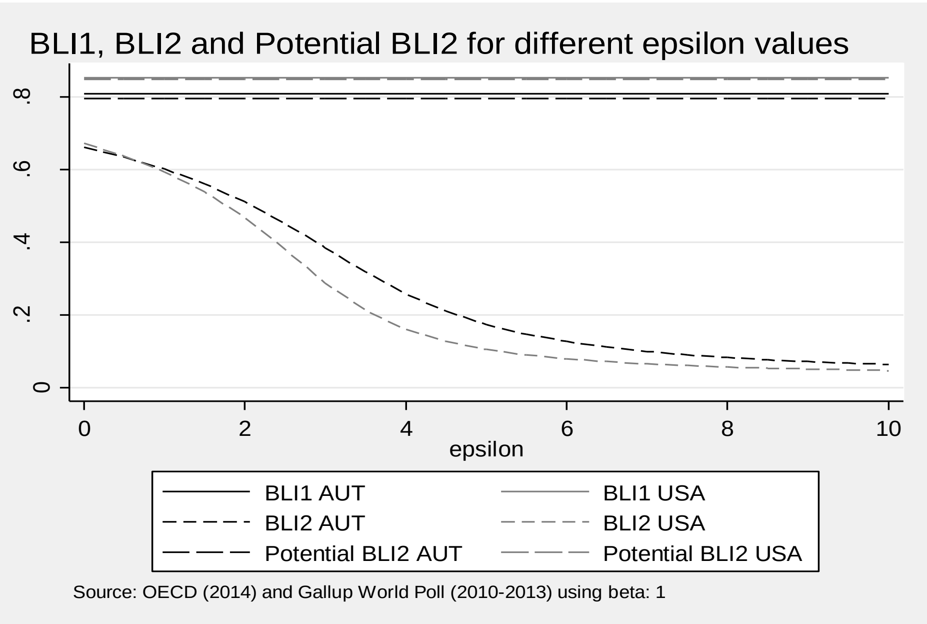
Source: OECD (2014) and Gallup World Poll (2010-2013) using epsilon: 2

70. When looking at the $BLI2$ (the short-dashed lines), Figure 8 shows a large drop when the dimensions are more seen as complements (so that each country is evaluated with more attention for its worst performance). This means that the loss due to multi-dimensional inequality increases sharply when the normative parameter β increases. Also the ranking of the United States and Austria depends on the choice for the parameter β. For values of β close to 0 (reflecting linear iso-well-being curves) the United

States has a higher $BLI2$, whereas for values of β between 0.8 and 2 Austria scores better. For higher values of β, losses due to multi-dimensional inequality become very large for both countries.

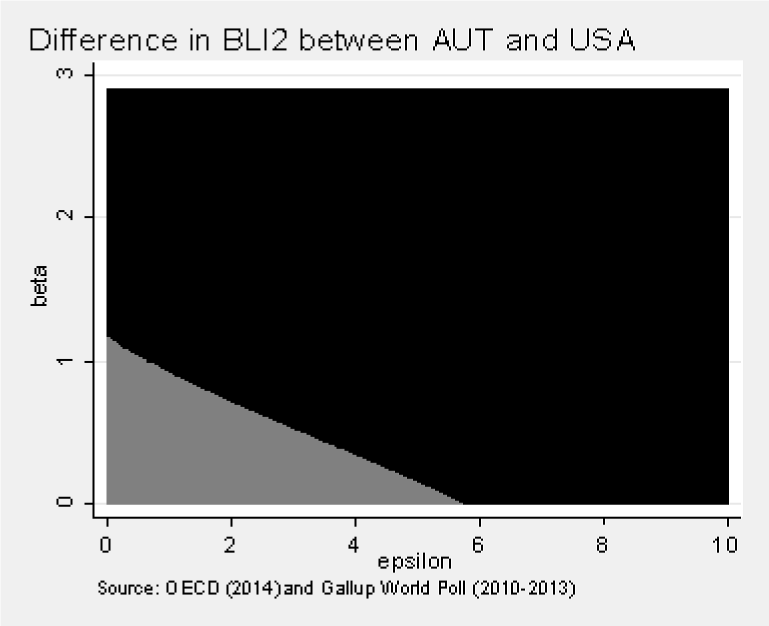
71. What is the role of the normative parameter ε, i.e. the inequality aversion? This can be analysed when fixing the parameter value of β at its benchmark value of 1. Figure 9 shows the evolution for $BLI1$, potential $BLI2$ and $BLI2$ for Austria (in black) and the United States (in gray). As can be seen from expression 9 and 11, $BLI1$ and potential $BLI2$ do not depend on the choice of the parameter ε. The United States scores better than Austria based on these measures. The picture changes when looking at $BLI2$. In this case, the position of the United States worsens compared to Austria for larger values of ε. For values beyond 1, Austria scores better than the United States.

Figure 9. BLI1, potential BLI2 and BLI2 for different values of the parameter ε



72. The comparison between Austria and the United States depends on both normative parameters. Figure 10 charts how the comparison of $BLI2$ of Austria and the United States depends on the choice of the parameter values. The United States scores better in the gray area, whereas Austria scores better in the black area. Austria scores best for high values of ε and β. The more the analysis focuses on the normative space around the origin (the case reflected by the orginal $BLI1$), the more the United States outperforms Austria. The comparison of both countries depends clearly on the interplay between both parameters. By using a simplified measure that equalizes both parameters *a priori*, this feature would be lost.

Figure 10. Comparison between BLI2 for Austria and the United States



5. Conclusion

73. We can now return to the central question of this paper: are we ready to compute a distribution-sensitive *Better Life Index* for all OECD countries? The answer to this question is in three steps.

74. First, this paper has shown how a distribution-sensitive *Better Life Index* can be designed theoretically when a perfect data set is available. The literature on multi-dimensional inequality and welfare provides five concrete recommendations. A broad class of distribution-sensitive *Better Life Indices* that generalizes the existing *Better Life Index* and satisfies these five recommendations was discussed. The resulting indices can be decomposed in their building blocks, which provide additional insights. From a theoretical perspective, the central question can be therefore answered with considerable optimism.

75. Of course, we do not live in a world without data constraints. Section 3 of the paper has shown that data limitations impose strong restrictions on the implementation of a distribution-sensitive *Better Life Index*. From an implementation perspective, the answer to the central question of the paper is therefore grimmer. To confront these data limitations, at least two strategies are possible. The first-best strategy is to collect better data, which is costly and labour-intense. The second-best strategy is to rely on a synthetic data set constructed by combining the available macro and micro-level information from different sources. The extent to which the results are sensitive to the assumptions implicit in the construction of such a synthetic data set is an important question for further research.

76. Section 4 of the paper has presented first results for a distribution-sensitive *Better Life Index* based on such a constructed synthetic data set. This exercise revealed some interesting insights. First, Nordic countries are top-ranked according to the distribution-sensitive Bette Life Index, while Mexico, Chile, Brazil, Greece, the Russian Federation and Turkey occupy the bottom positions. For these worse performing countries, this outcome reflects both low average scores in each of the dimensions and high level of multi-dimensional inequality.

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APPENDIX 1. ELICITING VALUES FOR THE NORMATIVE PARAMETERS

One of the novelties of the first generation of the *Better Life Index* has been the flexibility on the choice of the weighting scheme ω. On the web application (www.oecdbetterlifeindex.org), users can communicate the importance they want to give to the different dimensions by means of intuitive slider bars (see Figure 11). These importance-scores are then normalized so that they sum to 1 across the 11 dimensions for each user. The resulting values form the weighting scheme ω.[45]

Figure 11 BLI web application for setting user-weights

Source: www.oecdbetterlifeindex.org

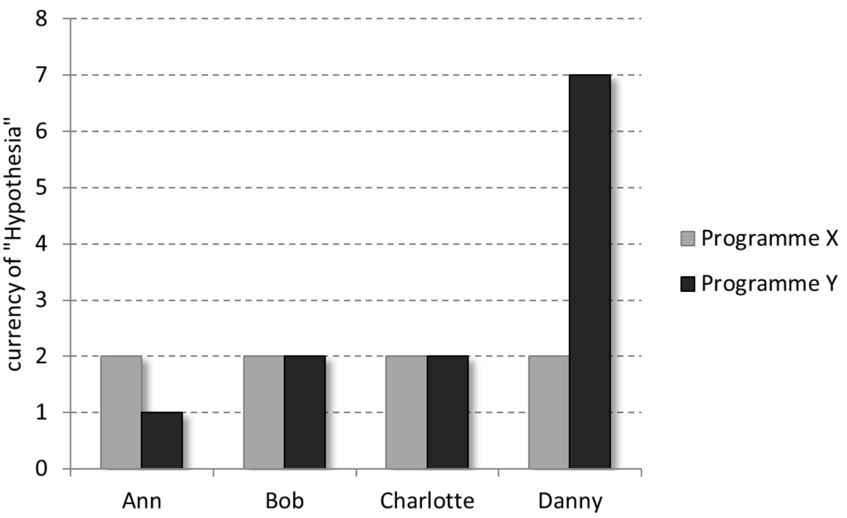
Introducing the distribution in the *Better Life index* would enlarge the set of normative parameters with two new parameters β and ε. Arguably these parameters are rather abstract and not part of the daily environment of most users.

45 Bottomley et al. (2000) discuss the implication of using importance scores on the resulting weighting schemes. The authors compare the method to so-called budget allocation, in which users attribute a fixed 'budget' to the dimensions. Bottomley et al. (2000) argue that the budget allocation question is cognitively more demanding, which makes the results less reliable from a test-retest perspective. Typically both methods lead to different results, with the opinions elicited by budget allocation being more extreme. Moreover, it remains unclear what the importance scores precisely mean from a theoretical perspective, as they don't require the users to make any trade-off. Do users think about the importance of marginal improvements in these dimensions or about large non-marginal improvements? In the latter case it becomes unclear how large the improvements precisely are and whether they are *überhaupt* comparable across dimensions, see also Decancq et al. (2013).

Should these parameters be included on the web-site, for instance by means of slider bars? There are at least three arguments to do so. First, the analysis in Section 4 has shown that both parameters matter empirically in the ranking of countries. Second, if users take the perspective of an impartial observer (or policy maker), their inequality aversion (and degree of complementarity between the dimensions) is an essential aspect of their normative position. Finally, eliciting values for the normative parameters needs not to be very difficult (see Amiel and Cowell 1999 for an extensive discussion). At least it does not seem more difficult than eliciting a weighting scheme based on importance scores. Clearly more research is needed on this question.

In addition, users could be helped to crystallize their normative parameters by first presenting them a few dichotomous normative choices and afterwards making the underlying normative position explicit. Figure 12 illustrates such a dichotomous choice. The user would be asked to imagine a hypothetical county ‘Hypothesia’ with four citizens (Ann, Bob, Charlotte, and Danny). In each of the next situations two programmes are proposed that result in two alternative income distributions X and Y (in the local currency of Hypothesia). It is known that both programmes will have the same effect on the population except on their incomes. The user is then asked to state which programme makes the people of Hypothesia better off by ticking the box of programme X or Y. Users who select Programme X prefer a more equal distribution with a smaller overall total to a more unequal distribution with a larger total (as depicted in Programme Y).

Figure 11. Dichotomous choice to help users to select the normative parameter ε



In fact, when the user relies on the so-called Atkinson social welfare function given in espression (7), it can be computed easily that a preference for programme X corresponds to a parameter value for ε value which is larger than 1.63. Similar choices could be repeated to shrink the range of normative parameters further. Alternatively the user could be given the opportunity to adjust one of the bars (the one of Danny, for instance) to reach two distributions that she considers equally good. Analogous techniques could be used to help users to make their choices on the parameter β.

APPENDIX 2. TWO ADDITIONAL DECOMPOSITIONS

The baseline decomposition discussed in Section 2 decomposes the distribution-sensitive $BLI2$ in the potential $BLI2$ and the loss due to multi-dimensional inequality.

$$\underbrace{BLI2(X|\omega,\beta,\varepsilon)}_{\substack{distribution- \\ sensitive \\ BLI2}} = \underbrace{BLI2(X_\mu|\omega,\beta,0)}_{Potential\ BLI2} \times \left[1 - \underbrace{\left(1 - \frac{BLI2(X|\omega,\beta,\varepsilon)}{BLI2(X_\mu|\omega,\beta,0)}\right)}_{\substack{loss\ due\ to \\ multidimensional \\ inequality}}\right]. \quad (11)$$

Both components of equation (11) can be decomposed further.

First, the potential $BLI2$ is decomposed, which highlights its relation to $BLI1$. There are two important differences between the two measures. First, the $BLI1$ is computed based on a data set that consists of macro-level indicators, X_m, rather than on the smoothed data set X_μ. As we have seen, the two data sets do not necessarily coincide. The 'loss to the micro-macro conversion' captures this difference (see equation 12).

$$\underbrace{BLI2(X_\mu|\omega,\beta,0)}_{Potential\ BLI2} = \underbrace{BLI2(X_m|\omega,0,0)}_{BLI1} \times \left[1 - \underbrace{\left(1 - \frac{BLI2(X_\mu|\omega,0,0)}{BLI2(X_m|\omega,0,0)}\right)}_{\substack{loss\ due\ to \\ micro-macro \\ conversion}}\right] \times \left[1 - \underbrace{\left(1 - \frac{BLI2(X_\mu|\omega,\beta,0)}{BLI2(X_\mu|\omega,0,0)}\right)}_{\substack{loss\ due\ to \\ aggregate \\ unbalancedness}}\right]. \quad (12)$$

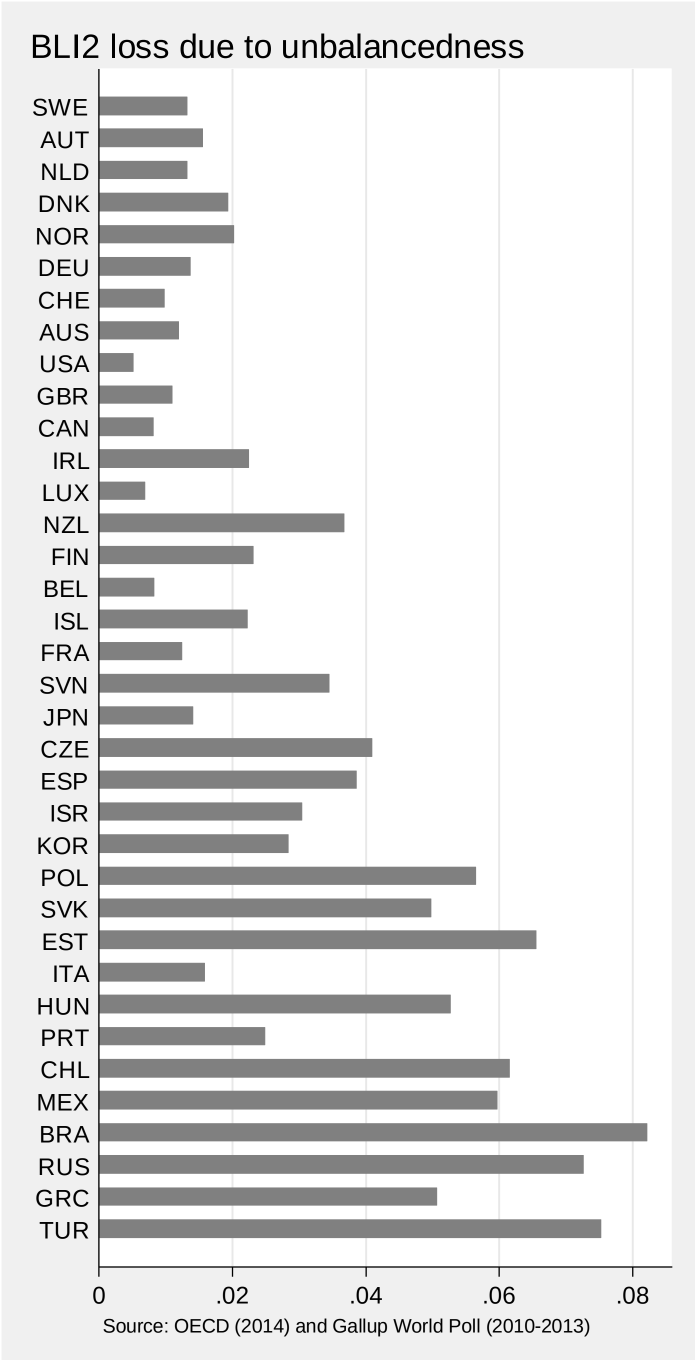
The $BLI1$ aggregates linearly across the dimensions of life (i.e. the degree of complementarity β is fixed at the value 0), whereas the potential $BLI2$ is more flexible, allowing for alternative choices of β. This second term of equation (12) captures the 'loss due to the aggregate un-balancedness' of the smoothed data set.

Equation (12) is useful to understand the difference between $BLI1$ and $BLI2$. In particular it allows distinguishing losses due to the conversion from micro to macro data, on the one hand, from the normative difference that comes from the choice of the β parameter, on the other. When $X_m = X_\mu$ (as is the case for the synthetic data constructed in this paper) the loss due to the micro-macro conversion is 0. Similarly, when $\beta = 0$ the loss due to aggregate unbalancedness is nil. For the benchmark normative case when $\beta = 1$, the loss due the aggregate un-balancedness is given by Figure 13.

Larger values reflect more unbalanced outcomes across the dimensions. For the selected normative parameters ω and β, losses due to aggregate unbalancedness are in general larger for countries at the bottom of the $BLI2$ ranking, but remain relatively small (less than 10%).

Figure 12. BLI2 loss due to aggregate unbalancedness

ε=2 and β=0



Second, also the ‘loss due to multi-dimensional inequality’ in equation (11) can be decomposed further into two elementary building blocks: the loss due to inefficiency and the loss due to inequity.

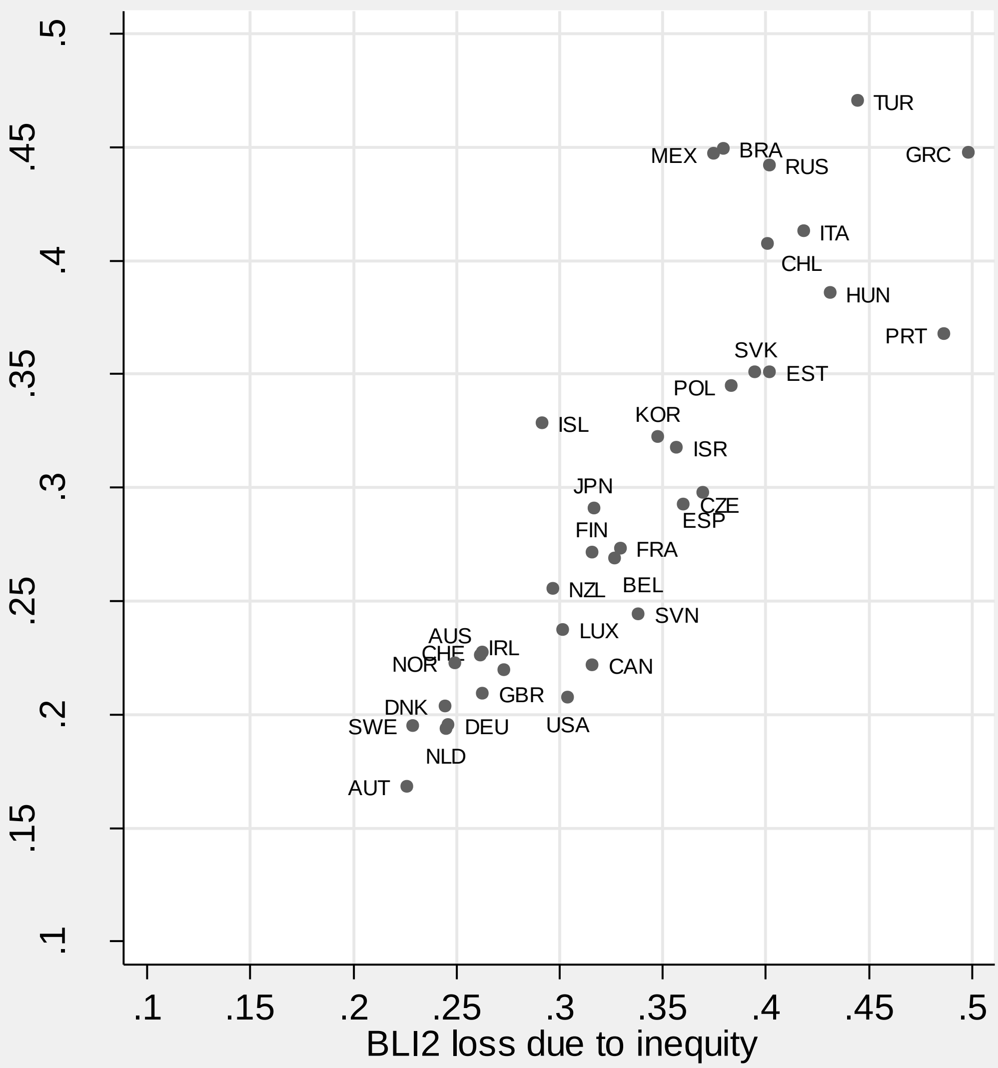
$$\left[1-\underbrace{\left(1-\frac{BLI2(X|\omega,\beta,\varepsilon)}{BLI2(X_{\mu}|\omega,\beta,0)}\right)}_{\substack{loss\ due\ to\\ multidimensional\\ inequality}}\right]=\left[1-\underbrace{\left(1-\frac{BLI2(X|\omega,\beta,0)}{BLI2(X_{\mu}|\omega,\beta,0)}\right)}_{\substack{loss\ due\ to\\ multidimensional\\ inefficienty}}\right]\times\left[1-\underbrace{\left(1-\frac{BLI2(X|\omega,\beta,\varepsilon)}{BLI2(X|\omega,\beta,0)}\right)}_{\substack{loss\ due\ to\\ multidimensional\\ inequity}}\right]. \qquad (13)$$

Again, this decomposition is based a simple accounting equation, but it offers interesting insights in the composition of multidimensional inequality. The loss due to multidimensional inequity captures the dispersion in the well-being levels of individuals within a country, whereas the multidimensional inefficiency measures the loss due to the potential mutual beneficial exchanges that could be made. Indeed, two individuals with the same well-being level (i.e when there is no multidimensional inequity), but with different outcomes in the dimensions of life could both improve their situation if it were possible for them to exchange some outcomes. The loss due to multidimensional inefficiency captures the latter effect. In fact, some observers have argued that the multidimensional analysis should be concerned with inequity alone, and not with inefficiency, and the decomposition in expression (13) allows them to do so (see Bosmans et al. (forthcoming) for a detailed discussion).

Figure 14 plots both components of multidimensional inequality for each country (recall the decomposition in expression (13)). The horizontal axis shows the loss due to inequity (i.e the dispersion in well-being levels between the individuals), whereas the vertical axis presents the inefficiency component (i.e the potential mutually beneficial exchanges). Multidimensional inequality is larger for countries in the top right-hand corner of the figure (e.g. Turkey and Greece). For most countries, inequity and inefficiency account in roughly equal parts for the loss due to multidimensional inequality. In other words, the loss due to multidimensional inequality does not only consist of inequity, but also the inefficiency component contributes to the total loss due to multidimensional inequality. Comparisons based on multidimensional inequality do not necessarily correspond to comparisons of multidimensional equity. Compare the United States and Iceland on Figure 7 for instance. Iceland records a larger loss due to multidimensional inequality than the United States (52% versus 45%), yet the well-being differences in the United States are larger (in Figure 14, the United States has a higher loss due to inequity compared to Iceland).

Figure 13. The inequity and inefficiency component of multi-dimensional inequality

ε=2 and β=0



Source: OECD (2014) and Gallup World Poll (2010-2013)

APPENDIX 3. COMPARISON WITH THE BLI1 PUBLISHED BY THE OECD

By construction the smoothed synthetic data set X_{μ} coincides with the macro data set X_m. Hence, there is no loss due to the micro-macro conversion. Yet, the $BLI2(X_m|\omega, 0,0)$ does not correspondent precisely to the Tables published by the OECD on www.oecdbetterlifeindex.org. Two modifications of the procedure to select and normalize the data are underlying this discrepancy.

First, the indicator to measure *Personal Security* in this paper has been changed to a more micro-oriented variable, i.e. self-reported safety (see also Table 5). This change leads to decrease in the level of the $BLI1$ for most member countries. For Mexico, however, the modification leads to an increase of about 5%. This increase can be attributed to the low score of Mexico on the original variable (the unweighted average of the number of reported homicides and the self-reported victimisation rate).

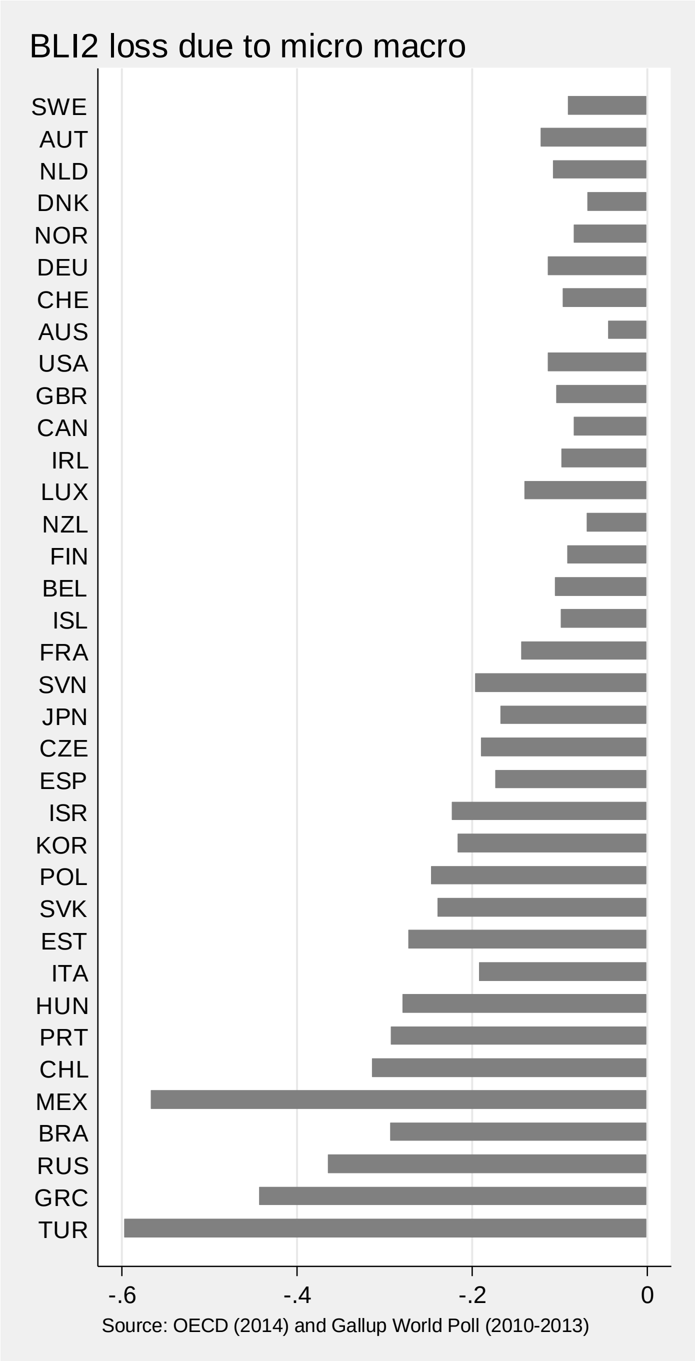
Second, the linear normalization used by the OECD to map the outcomes in each variable between 0 and 1 is replaced by a simple rescaling of the variables by their respective maximal value. To be precise, the original OECD formula is given by equation (15) where $\underline{x}_j$ is the dimension-specific minimum in dimension j and $\overline{x}_j$ the dimension-specific maximum.

$$\frac{x_j - \underline{x}_j}{\overline{x}_j - \underline{x}_j} \quad \text{for each dimension } j \qquad (14)$$

The normalization used in this paper sets $\underline{x}_j$ at zero for each dimension, so that the normalization boils down to a simple rescaling by the dimension-specific maximum. This modification assures that also the bottom-performing individuals in the bottom-performing countries can have a positive score.

Figure 15 summarizes the comparison between $BLI2(X_m|\omega, 0,0)$ as used in this paper and the tables published by the OECD. For all countries, the losses due to the two modifications in this paper are negative, and hence are welfare gains that lead to an higher $BLI2(X_m|\omega, 0,0)$ compared to the published tables. The gains are largest for bottom ranked countries (and sizeable for some of them). This finding is intuitive, as the second modification leads to a potentially large increase in the index score for bottom-performing countries.

Figure 14. Impact of the OECD normalization procedure



APPENDIX 4. SUMMARY STATISTICS OF THE SYNTHETIC DATA SET

Table 9. Gini coefficients for the eight non-equal dimensions of life based on the synthetic data

	Income and Wealth	Jobs and Earnings	Health	Education and Schooling	Social Connect-ions	Environ-mental Quality	Personal Security	Subjective Well-Being
Australia	0.324	0.106	0.190	0.178	0.051	0.076	0.395	0.126
Austria	0.282	0.081	0.168	0.163	0.055	0.075	0.185	0.130
Belgium	0.269	0.092	0.234	0.263	0.077	0.190	0.345	0.121
Brazil	0.469	0.117	0.201	0.513	0.091	0.240	0.617	0.168
Canada	0.316	0.103	0.198	0.294	0.062	0.118	0.257	0.122
Chile	0.503	0.121	0.242	0.403	0.166	0.242	0.495	0.180
Czech Republic	0.256	0.094	0.230	0.224	0.093	0.188	0.419	0.169
Denmark	0.253	0.118	0.260	0.155	0.041	0.059	0.218	0.107
Estonia	0.323	0.089	0.305	0.378	0.096	0.215	0.379	0.194
Finland	0.261	0.087	0.229	0.396	0.062	0.076	0.237	0.113
France	0.309	0.099	0.155	0.315	0.077	0.188	0.367	0.141
Germany	0.293	0.089	0.220	0.168	0.060	0.073	0.269	0.145
Greece	0.336	0.246	0.200	0.433	0.197	0.280	0.534	0.250
Hungary	0.29	0.108	0.305	0.417	0.106	0.190	0.481	0.244
Iceland	0.251	0.074	0.190	0.611	0.028	0.054	0.192	0.107
Ireland	0.300	0.152	0.138	0.231	0.0352	0.091	0.333	0.146
Israel	0.377	0.093	0.220	0.212	0.110	0.345	0.398	0.126
Italy	0.322	0.134	0.146	0.622	0.109	0.261	0.427	0.164
Japan	0.336	0.089	0.199	0.349	0.112	0.148	0.356	0.175
Korea	0.307	0.112	0.229	0.264	0.179	0.208	0.472	0.173
Luxembourg	0.276	0.082	0.171	0.299	0.087	0.123	0.284	0.124
Mexico	0.482	0.132	0.174	0.523	0.194	0.230	0.488	0.166
Netherlands	0.278	0.106	0.209	0.199	0.066	0.110	0.259	0.089
New Zealand	0.323	0.126	0.174	0.277	0.052	0.086	0.404	0.126
Norway	0.250	0.099	0.249	0.303	0.049	0.045	0.144	0.118
Poland	0.304	0.106	0.294	0.358	0.072	0.204	0.329	0.183
Portugal	0.341	0.106	0.245	0.504	0.141	0.117	0.387	0.239
Russian Federation	0.356	0.075	0.359	0.298	0.104	0.434	0.573	0.199
Slovak Republic	0.262	0.112	0.266	0.321	0.082	0.200	0.460	0.178
Slovenia	0.245	0.092	0.255	0.229	0.074	0.151	0.199	0.197
Spain	0.344	0.207	0.159	0.315	0.059	0.176	0.293	0.176
Sweden	0.273	0.097	0.209	0.213	0.065	0.062	0.232	0.116
Switzerland	0.289	0.077	0.175	0.311	0.052	0.086	0.248	0.103
Turkey	0.412	0.136	0.198	0.550	0.248	0.336	0.446	0.228
United Kingdom	0.344	0.118	0.174	0.209	0.058	0.072	0.306	0.149
United States	0.389	0.152	0.188	0.181	0.078	0.122	0.286	0.160

Table 10. Average score for the eleven dimensions of life based on the synthetic data

	Income and Wealth	Jobs and Earnings	Housing	Health	Work/Life Balance	Civic Engage-ment	Education and Schooling	Social Connect-ions	Environ-mental Quality	Personal Security	Subjective Well-Being
Australia	0.539	0.859	0.707	0.972	0.784	0.957	0.896	0.968	0.834	0.750	0.947
Austria	0.551	0.861	0.597	0.877	0.850	0.712	0.886	0.990	0.692	0.946	0.964
Belgium	0.647	0.788	0.688	0.897	0.938	0.674	0.884	0.947	0.701	0.792	0.914
Brazil	0.156	0.639	0.453	0.831	0.842	0.595	0.676	0.935	0.647	0.469	0.925
Canada	0.620	0.819	0.730	0.982	0.898	0.786	0.924	0.978	0.802	0.896	0.977
Chile	0.242	0.663	0.398	0.803	0.770	0.557	0.802	0.889	0.405	0.602	0.849
Czech Republic	0.286	0.691	0.529	0.804	0.884	0.612	0.938	0.903	0.739	0.714	0.861
Denmark	0.469	0.818	0.631	0.879	0.976	0.775	0.904	1.000	0.825	0.928	0.976
Estonia	0.211	0.620	0.446	0.751	0.922	0.482	0.935	0.926	0.812	0.751	0.690
Finland	0.416	0.777	0.633	0.873	0.921	0.761	0.955	0.972	0.825	0.914	0.957
France	0.550	0.717	0.637	0.874	0.877	0.583	0.840	0.947	0.806	0.773	0.857
Germany	0.575	0.831	0.630	0.850	0.912	0.579	0.928	0.968	0.815	0.878	0.896
Greece	0.294	0.367	0.481	0.915	0.899	0.618	0.839	0.712	0.544	0.574	0.607
Hungary	0.244	0.590	0.439	0.766	0.935	0.687	0.886	0.910	0.731	0.642	0.632
Iceland	0.446	0.842	0.612	0.932	0.796	0.660	0.878	1.000	0.810	0.948	0.965
Ireland	0.406	0.666	0.699	0.953	0.925	0.767	0.874	0.996	0.792	0.811	0.869
Israel	0.468	0.726	0.476	0.949	0.734	0.472	0.852	0.934	0.606	0.705	0.914
Italy	0.517	0.657	0.557	0.861	0.924	0.621	0.788	0.953	0.686	0.714	0.773
Japan	0.638	0.816	0.496	0.667	0.703	0.633	0.935	0.941	0.679	0.782	0.768
Korea	0.335	0.814	0.572	0.695	0.642	0.858	0.919	0.802	0.571	0.657	0.772
Luxembourg	0.666	0.864	0.629	0.895	0.934	0.749	0.814	0.922	0.778	0.858	0.917
Mexico	0.202	0.691	0.440	0.815	0.600	0.730	0.642	0.770	0.528	0.587	0.957
Netherlands	0.593	0.861	0.677	0.918	0.974	0.666	0.891	0.959	0.656	0.896	0.952
New Zealand	0.304	0.772	0.657	0.989	0.812	0.844	0.883	1.000	0.840	0.753	0.936
Norway	0.437	0.906	0.719	0.901	0.949	0.773	0.899	0.969	0.817	1.000	0.987
Poland	0.244	0.619	0.436	0.787	0.854	0.764	0.946	0.934	0.537	0.793	0.739
Portugal	0.349	0.539	0.643	0.766	0.858	0.594	0.726	0.891	0.749	0.748	0.663
Russian Federation	0.230	0.727	0.319	0.624	0.964	0.459	0.897	0.878	0.568	0.524	0.712
Slovak Republic	0.254	0.543	0.489	0.814	0.892	0.605	0.891	0.922	0.783	0.664	0.763
Slovenia	0.320	0.708	0.602	0.822	0.889	0.797	0.916	0.967	0.682	0.947	0.768
Spain	0.378	0.392	0.668	0.918	0.931	0.685	0.790	0.961	0.630	0.838	0.791
Sweden	0.557	0.792	0.634	0.941	0.957	0.927	0.929	0.948	0.885	0.921	0.956
Switzerland	0.768	0.923	0.637	0.954	0.882	0.627	0.912	0.986	0.770	0.902	1.000
Turkey	0.187	0.582	0.275	0.826	0.418	0.709	0.669	0.822	0.427	0.651	0.629
United Kingdom	0.553	0.781	0.621	0.923	0.820	0.853	0.862	0.977	0.834	0.825	0.89
United States	1.000	0.829	0.735	0.975	0.812	0.716	0.909	0.942	0.756	0.861	0.904

Source: OECD (2014) and Gallup World Poll (2010-2013)